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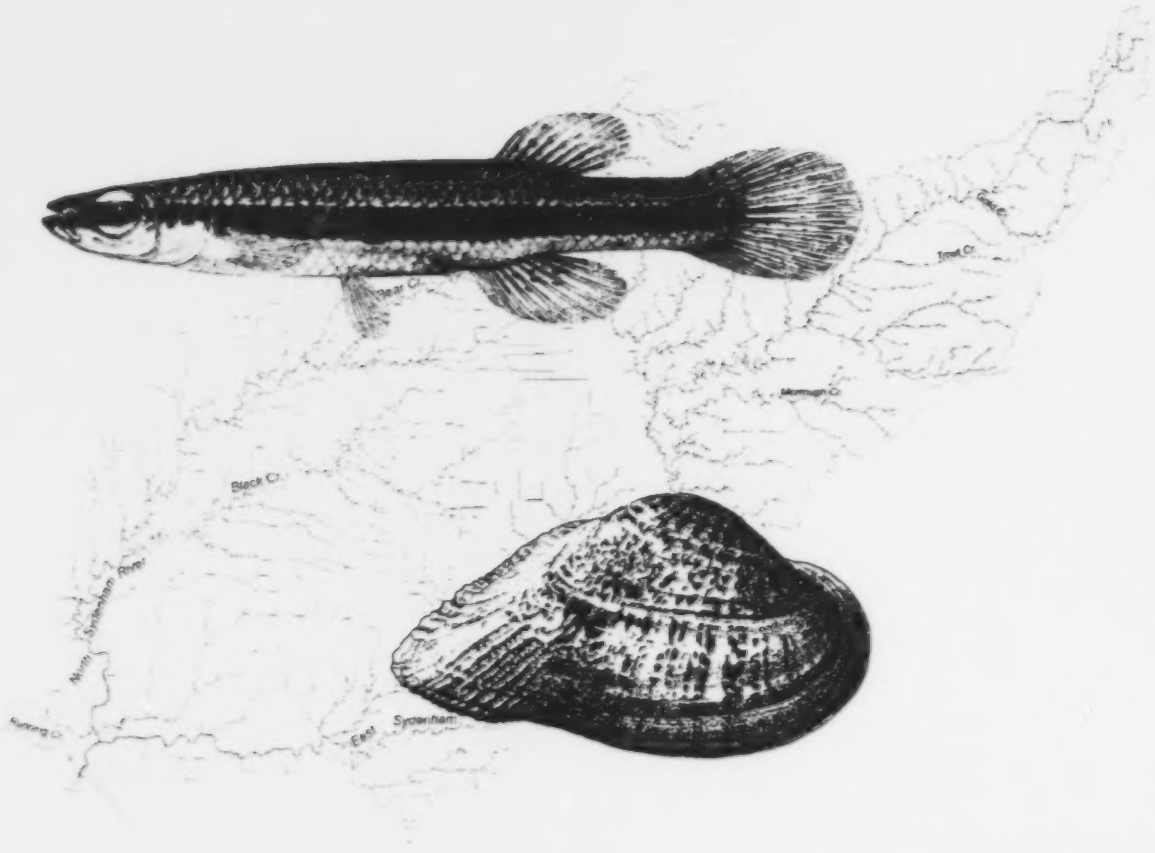
National Recovery Strategy for Species At Risk in the

Sydenham River: An Ecosystem Approach



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For additional copies contact:

Recovery Secretariat
c/o Canadian Wildlife Service
Environment Canada
Ottawa, Ontario
K1A 0H3

Tel.: 819-953-1410
Fax: 819-994-3684

E-mail: RENEW@ec.gc.ca

Recovery Web Site:
http://www.speciesatrisk.gc.ca/recovery/default_e.cfm

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National Recovery Strategy for Species At Risk in the Sydenham River: An Ecosystem Approach

Prepared by

A.J. Dextrase, S.K. Staton, and J.L. Metcalfe-Smith

on behalf of the
Sydenham River Ecosystem Recovery Team

Alan Dextrase, Ontario Ministry of Natural Resources (Chair)
Shawn Staton, Fisheries and Oceans Canada (Coordinator)
Janice Metcalfe-Smith, Environment Canada, National Water Research Institute
Gerry Mackie, University of Guelph
Muriel Andreae, St. Clair Region Conservation Authority
Mark Emery, Stewardship Kent
Trevor Friesen, Ontario Ministry of Natural Resources
Don Hector, Ontario Ministry of Natural Resources
Thom Heiman, Fisheries and Oceans Canada
Erling Holm, Royal Ontario Museum
Jack Imhof, Ontario Ministry of Natural Resources
Lindsay Anderson, Rural Lambton Stewardship Network
Ron Ludolph, Rural Lambton Stewardship Network
Mike Nelson, University of Guelph
Dan Schaefer, Middlesex Stewardship Committee
Don Sutherland, Ontario Ministry of Natural Resources
Daelyn Woolnough, University of Guelph
Dave Zanatta, Environment Canada
Ed Paleczny (initial chair of the Recovery Team), Ontario Ministry of Natural Resources
Joanne Di Maio, (formerly of Environment Canada)
Larry Cornelis, Sydenham Field Naturalists, Lambton Wildlife Inc.
Earl Elgie, Landowner – Chatham-Kent County
David Ferguson, Agricultural landowner – Lambton County
Randy Gorton, Farmers and Friends
Doug McGee, Agricultural landowner – Lambton County
Bill Thirlwall, Agricultural landowner – Middlesex County

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Adair Ireland-Smith
Director, Ontario Parks
Ontario Ministry of Natural Resources

Date: 19 November 2002

Howard Powles
Director, Biodiversity Science
Fisheries and Oceans Canada

Date: 11 June 2003

Frederick J. Wrona
Director, Aquatic Ecosystem Impacts Research Branch
National Water Research Institute
Environment Canada

Date: 8 November 2002

Disclaimer

This Recovery Strategy has been submitted by the Sydenham River Recovery Team to define recovery actions necessary to protect and recover aquatic species at risk in the Sydenham River. It does not necessarily represent the views of the individuals involved in the Strategy's formulation or the official positions of the organizations with which the individual team members are associated. The goals, objectives, and recovery approaches identified in the Strategy are based on the best existing knowledge and are subject to modifications resulting from new findings and revised objectives. We recognize that implementation of the Strategy will be subject to priorities and budgetary constraints imposed by participating jurisdictions and organizations. References to the federal Species at Risk Act (SARA) and information about species status are current as of July 2002 when this Strategy was approved.

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For Additional Information

For more information, please contact the Recovery Team Chair:

Alan Dextrase
Ontario Ministry of Natural Resources
300 Water Street
Peterborough, Ontario
Canada
K9J 8M5

Foreword

In 1999, a Recovery Team was formed to develop a strategy to help recover "species at risk" in the Sydenham River. The team adopted an ecosystem approach, which addresses all of these species in a single strategy for the river. This approach involved a consideration of all species in the river, their interactions, and the relationship between the river and the lands in the watershed. The Recovery Strategy contains both overall approaches that address watershed issues as well as species-specific approaches that address individual needs of species at risk[1]. Successful implementation of the recovery approaches contained in this Strategy will result in improved water quality and a healthy ecosystem for all native species that are present in the Sydenham River. It is recognized that several of the species at risk present in the Sydenham River also occur elsewhere in Canada. Therefore, efforts to recover these species in Canada must go beyond the approaches recommended in this Strategy. While the Recovery Team recognizes that there are several terrestrial species at risk that reside in the Sydenham River watershed (e.g., Northern Bobwhite, Kentucky coffee tree), a conscious decision was made to address only those species that are truly aquatic. However, efforts were made to ensure that approaches recommended in this Strategy are consistent with the protection of terrestrial species.

Prior to the preparation of this Recovery Strategy, the Recovery Team prepared four background reports and a synthesis report on the Sydenham River watershed and its species at risk. During this period, information sessions and community meetings were held with stakeholders in the watershed. The Recovery Team recognizes that the development and implementation of successful Recovery Action Plans can take place only with the full involvement and support of landowners and other stakeholders in the watershed. Partnerships, awareness, and stewardship are fundamental components of the Strategy and will continue to play a major role throughout its implementation.

Executive Summary

The Sydenham River in southwestern Ontario supports an astonishing diversity of aquatic species. This watershed is located in the species-rich Carolinian Zone and supports the greatest diversity of freshwater mussels in all of Canada. At least 34 species of mussels and 80 species of fish have been found there. Many of these fish and mussels are rare, and 14 species in the Sydenham River have been listed nationally by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). These species, which include five mussels, eight fishes, and one turtle, are listed as follows (E = Endangered, T = Threatened, SC = Special Concern): wavy-rayed lampmussel (E), rayed bean (E), northern rifflesheil (E), snuffbox (E), mudpuppy mussel (E), eastern sand darter (T), spotted gar (T), northern madtom (SC), spotted sucker (SC), pugnose minnow (SC), blackstripe topminnow (SC), greenside darter (SC), bigmouth buffalo (SC), and eastern spiny softshell (T). Some of these species, such as the rayed bean, are found nowhere else in Canada and remain at only a few locations across North America. The Sydenham River watershed is of global significance to the conservation of these species.

The Sydenham River is a large river with two main branches (North Sydenham and East Sydenham) that drain into Lake St. Clair in southwestern Ontario. The entire watershed is of low relief, with low stream gradients and shallow valleys. Although pre-settlement land cover was 70% forest and 30% swamp, the watershed is now predominantly agricultural (85%), with extensive drainage, and most of the wetlands have been lost. The system is currently nutrient-rich and turbid. Substrates and habitats in the East Sydenham River are more diverse than those in the north branch. Most of the endangered and threatened species inhabit the middle section of the East Sydenham River, while species of special concern can be found in both branches of the river.

[1] Recovery goals, objectives, and approaches for the eastern spiny softshell were drawn from the draft recovery plan for the eastern spiny softshell (Oldham *et al.* 1997).

A synthesis of all available background information indicated that the principal stresses affecting populations of species at risk in the Sydenham River watershed are sediment loadings causing turbidity and siltation, nutrient loads, toxic compounds, thermal effects, and exotic species. All identified threats are widespread and chronic in nature and believed to be the key stresses driving historical declines of many sensitive aquatic species. Although sediment loadings have been identified as the primary limiting factor for most species at risk, it is important to recognize that population declines are, in most cases, likely a result of the cumulative impacts of many interacting stresses.

The Recovery Strategy employs an ecosystem approach that will benefit several species at risk as well as other native species in the Sydenham River watershed. Recovery actions that benefit the endangered and threatened species (and the portion of the East Sydenham River that they inhabit) are of highest priority in this Strategy. The Recovery Strategy is organized in three parts: the first relates to goals and approaches for overall ecosystem recovery; the second relates to goals and approaches for the three organism groups (mussels, fishes, and a turtle); and the third includes species-specific information summaries for each of the 14 COSEWIC-listed species.

Overall Recovery of the Sydenham River Ecosystem

The long-term goal of this Recovery Strategy is to sustain and enhance the native aquatic communities of the Sydenham River through an ecosystem approach that focuses on species at risk. The short-term recovery objectives to be addressed over the next five years are as follows:

I. Maintain the current geographical distributions and abundances of species at risk.
II. Improve water and habitat quality by reducing sediment loads and nutrient and chemical inputs and ensuring that the base flow rate is maintained.
III. Reduce the risk of the introduction of exotic species in the watershed.
IV. Establish a broad-based monitoring program that assesses the physical, chemical, and biological characteristics of the system.
V. Promote stewardship by encouraging a sense of public ownership and involvement among landowners, stakeholders, those working in the watershed, and other interested citizens.
VI. Generate awareness regarding the Sydenham River and the significance of its natural heritage.
VII. Enhance the understanding of key aspects of the Sydenham River ecosystem that will lead to further refinement and prioritization of essential recovery actions.

Overall approaches and specific steps to achieve these objectives have been organized into four categories, which correspond to Recovery Action Groups (RAGs) that will implement the Recovery Strategy:

1. Management Approaches: Nine approaches are identified that provide habitat protection through habitat identification and mapping and the transfer of this information to planning agencies (e.g., municipalities) and investigating effective policy, legislative, and incentive programs to protect species at risk.
2. Stewardship/Habitat Improvement Approaches: Twelve approaches are identified to improve habitat in rural areas through incentive-based programs and demonstration projects that will improve water quality. Waste management, riparian buffers, livestock access, and conservation tillage will be important components of the stewardship approaches. The stretch of the East Sydenham River from just upstream of Alvinston downstream to Dawn Mills has been identified as a high conservation priority zone, and habitat improvement projects benefiting this section of river should be given highest priority.
3. Research and Monitoring Approaches: Ten approaches are identified to track changes in the Sydenham River ecosystem (water quality, habitat, species at risk) and address important research questions that need to be answered to implement effective recovery actions.
4. Community Awareness and Outreach Approaches: Three approaches are identified to increase awareness regarding the Sydenham River. The key element in this section is the development of a communications strategy and associated products that will support many elements of the Recovery Strategy.

Significant progress has already been made on several recovery actions during the preparation of this Strategy. The Sydenham River Stewardship Initiative was established in 2000 through the local stewardship councils (Lambton, Kent, Middlesex) and the St. Clair Region Conservation Authority to provide landowners with financial and technical support to assist them with habitat improvement projects. The program is ongoing and supported by the Government of Canada's Habitat Stewardship Program for Species at Risk. The Recovery Team has held several meetings and workshops with landowners and other stakeholders in the watershed to gain input into the Strategy and has produced an educational poster on species at risk in the watershed. There have also been several recent surveys and reports prepared on the status of the watershed, and many research projects are ongoing.

There are several existing management plans that are related to this Recovery Strategy (e.g., watershed plan, municipal plans, and recovery plans for terrestrial species). Where necessary, implementation efforts will need to be harmonized with these plans to avoid conflicts.

The Recovery Team has consulted with interested stakeholders and facilitated the formation of four RAGs to implement the Recovery Strategy. RAGs are responsible for drafting their own Recovery Action Plans (RAPs) using the corresponding strategies/approaches section of this Recovery Strategy (Management, Stewardship, Research and Monitoring, and Community Awareness and Outreach). These four RAGs were established in spring 2002, and RAPs were drafted in fall 2002. The successful implementation of some strategies will require the coordinated efforts of more than one RAG, with overall management/coordination by the Recovery Team.

Evaluation of the overall approaches to recovery set out in this Strategy will be largely accomplished through the routine monitoring program. This program will assess the status of water quality, species at risk, and in-stream habitat through time. Where possible, target levels have been established to assess progress. Evaluation measures will also be incorporated into the awareness strategy to assess the effectiveness of awareness efforts. The Recovery Strategy will be reviewed in 5 years to evaluate the progress on stated objectives and to identify additional approaches and changes that may be required.

Recovery and survival habitats are described for each individual species. As a general rule, survival habitat was defined as those reaches of the river that are currently occupied by the species in question, while recovery habitat was defined as those reaches currently and historically occupied by the species. In a few cases, recovery and survival habitats are equivalent, as there has been no known range retraction for some species. The condition of the riparian zone has a great influence on the in-stream habitats on which the species at risk depend. However, all of the species are entirely aquatic with the exception of the eastern spiny softshell, which uses riparian habitat for nesting and basking. Therefore, recovery and survival habitats for mussels and fishes are defined in this Strategy as areas below the "top of bank"[2] only. Much of the recovery work will concentrate on improving the condition of the Sydenham River's riparian zone to improve these in-stream habitats.

Several knowledge gaps are identified that do not appear in the section on recovery strategies and approaches. The Research and Monitoring RAG will need to review all of these research requirements and establish priorities for their implementation, to ensure that priority approaches can be implemented in a timely fashion.

Species-Specific Recovery

Specific goals and objectives and associated recovery approaches are established for each organism group (mussels, fishes, and a turtle) in this section. The long-term goal for mussels (five species) and fishes (eight species) is to maintain existing populations and restore each species to areas of the river where it formerly occurred. The long-term goal for the eastern spiny softshell is to maintain existing populations (there is no evidence of a decline). Short-term objectives generally relate to defining habitats and population trends and other information needs for each species. Recovery approaches identified in this section address species-specific needs that are not necessarily

2 The "top of bank" includes the area of active stream flow of a river in unflooded condition. It is defined by a marked change in the substrate slope from a horizontal profile to a more vertical profile and/or a visible change in floral abundance and character on vegetated slopes (OMNR 1989).

addressed in the overall ecosystem approaches in the first part of the Strategy. These include species-specific population and habitat monitoring needs, research questions (e.g., determination of fish hosts for mussels), habitat protection (nesting sites of eastern spiny softshells), and reintroduction plans.

Species-Specific Information Summaries

This section provides a summary of important biological information for each individual species. Information provided includes distribution, population sizes and trends, threats and limiting factors, habitat requirements, recovery potential, and knowledge gaps.

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Introduction

The Sydenham River in southwestern Ontario (Fig. 1) supports an astonishing diversity of aquatic species. This watershed is located in the species-rich Carolinian Zone and supports the greatest diversity of freshwater mussels (*Unionidae*) in all of Canada. At least 34 species of mussels and 80 species of fish have been found here. Many of these fishes and mussels are rare, and 14 species (five mussels, eight fishes, and one turtle) in the Sydenham River have been assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as Endangered, Threatened, or of Special Concern (Table 1). Another nine species of mussels, two species of fish, and eight species of Odonata (dragonflies and damselflies) are considered rare in Ontario by the province's Natural Heritage Information Centre. Some of these species, such as the rayed bean, are found nowhere else in Canada and remain at only a few locations across North America. Similarly, the Sydenham River population of the northern riffleshell is one of only three populations remaining that still show evidence of successful reproduction. As such, the Sydenham River watershed is of global significance to the conservation of these species.

To ensure the continued survival of these aquatic species at risk, the Sydenham River Recovery Team was formed with the overall objective of developing an ecosystem-based recovery strategy for this globally significant watershed. The ecosystem approach in the context of the Sydenham River recognizes the links between species, communities, and the land and water base that support them. Its objective is to maintain or enhance the natural processes that support the aquatic communities in the river through managing the impacts of human activities that occur on land and water within the watershed. The benefits of an ecosystem approach include the following:

- Recovery actions are selected that benefit several species at risk (including species of special concern, which are not normally addressed in recovery strategies).
- Implementation is generally more cost-effective than for a single-species approach.
- It addresses issues of scale.
- It targets mitigation and rehabilitation of impacts, and it restores ecosystem health to prevent the decline of other native species.
- It ensures that actions taken to benefit individual species do not negatively impact other species at risk in the area.

National recovery efforts under the auspices of the national recovery program (Recovery of Nationally Endangered Wildlife, or RENEW) are directed towards species assessed by COSEWIC as extirpated, endangered, or threatened. Species of special concern are normally addressed through management plans. In this Recovery Strategy, species of special concern are addressed, but the priority is on threatened and endangered species.

Background information used in the preparation of this Recovery Strategy is available from the report entitled Sydenham River Recovery Project: Synthesis and analysis of background data (Jacques Whitford Environment Ltd. 2001). This report synthesizes available information on four key background reports prepared or commissioned by the Recovery Team for the Sydenham River watershed on species at risk (Dextrase et al. 2000), water quality (Di Maio 2000), fluvial geomorphology (Parish Geomorphic Ltd. 2000), and land use and land cover (Nelson 2001). In addition, national status reports are available for the 14 aquatic species listed by COSEWIC (Appendix 3).

This Recovery Strategy has been organized in three parts. The first section relates to goals and approaches for overall ecosystem recovery. The second section relates to overall goals and approaches for the three organism groups (mussels, fishes, and a turtle). Finally, Appendix 1 includes species-specific summaries for each of the 14 COSEWIC-listed species.

Table 1
List of species at risk and provincially rare species in the Sydenham River watershed (see Appendix 2 for definitions of ranks and status).

Common Name[1]	Species	G-Rank	S-Rank	COSEWIC Status	OMNR[2] Status
Mussels					
Wavy-rayed lampmussel*	*Lampsilis fasciola*	G4	S1	END	
Rayed bean*	*Villosa fabalis*	G1G2	S1	END	
Northern rifflеshell*	*Epioblasma torulosa rangiana*	G2T2	S1	END	
Snuffbox*	*Epioblasma triquetra*	G3	S1	END	
Mudpuppy mussel*	*Simpsonaias ambigua*	G3	S1	END	
Threehorn wartyback	*Obliquaria reflexa*	G5	S1		
Round hickorynut	*Obovaria subrotunda*	G4	S1	status under review	
Round pigtoe	*Pleurobema sintoxia*	G4	S1		
Kidneyshell	*Ptychobranchus fasciolaris*	G4G5	S1	status under review	
Lilliput	*Toxolasma parvus*	G5	S1		
Fawnsfoot	*Truncilla donaciformis*	G5	S2		
Paper pondshell	*Utterbackia imbecillis*	G5	S2		
Rainbow	*Villosa iris*	G5	S2S3		
Wabash pigtoe	*Fusconaia flava*	G5	S2S3		
Fishes					
Eastern sand darter*	*Ammocrypta pellucida*	G3	S2	THR	
Spotted gar*	*Lepisosteus oculatus*	G5	S2	THR	THR
Northern madtom*	*Noturus stigmosus*	G3	S1S2	SC	THR
Spotted sucker	*Minytrema melanops*	G5	S2	SC	VUL
Pugnose minnow	*Opsopoeodus emiliae*	G5	S2	SC	VUL
Blackstripe topminnow	*Fundulus notatus*	G5	S2	SC	VUL
Greenside darter	*Etheostoma blennioides*	G5	S3	SC	NIAC
Bigmouth buffalo	*Ictiobus cyprinellus*	G5	SU	SC	NIAC
Ghost shiner	*Notropis buchanani*	G5	S2	NAR	
Brindled madtom	*Noturus miurus*	G5	S2	NAR	NIAC
Turtles					
Eastern spiny softshell*	*Apalone spinifera spinifera*	G5T5	S3	THR	THR
Dragonflies and Damselflies					
Spatterdock darner	*Aeshna mutata*	G3G4	S1		
Citrine forktail	*Anomalagrion hastatum*	G5	S1		
Double-striped bluet	*Enallagma basidens*	G5	S2		
Pronghorn clubtail	*Gomphus grasinellus*	G5	S2S3		
Ashy clubtail	*Gomphus lividus*	G5	S2S4		
Green-faced clubtail	*Gomphus viridifrons*	G3	S1		
Painted skimmer	*Libellula semifasciata*	G5	S2		
Elusive clubtail	*Stylurus notatus*	G3	S2		

[1] Species marked with an asterisk (*) have been assessed by the Recovery Team as having a high conservation priority (see Dextrase et al. 2000). National recovery programs are directed at COSEWIC-listed Endangered (END) and Threatened (THR) species.

[2] Ontario Ministry of Natural Resources.

Figure 1
Map of the Sydenham River watershed in southwestern Ontario (inset: map of southern Ontario showing the location of the Sydenham River watershed).

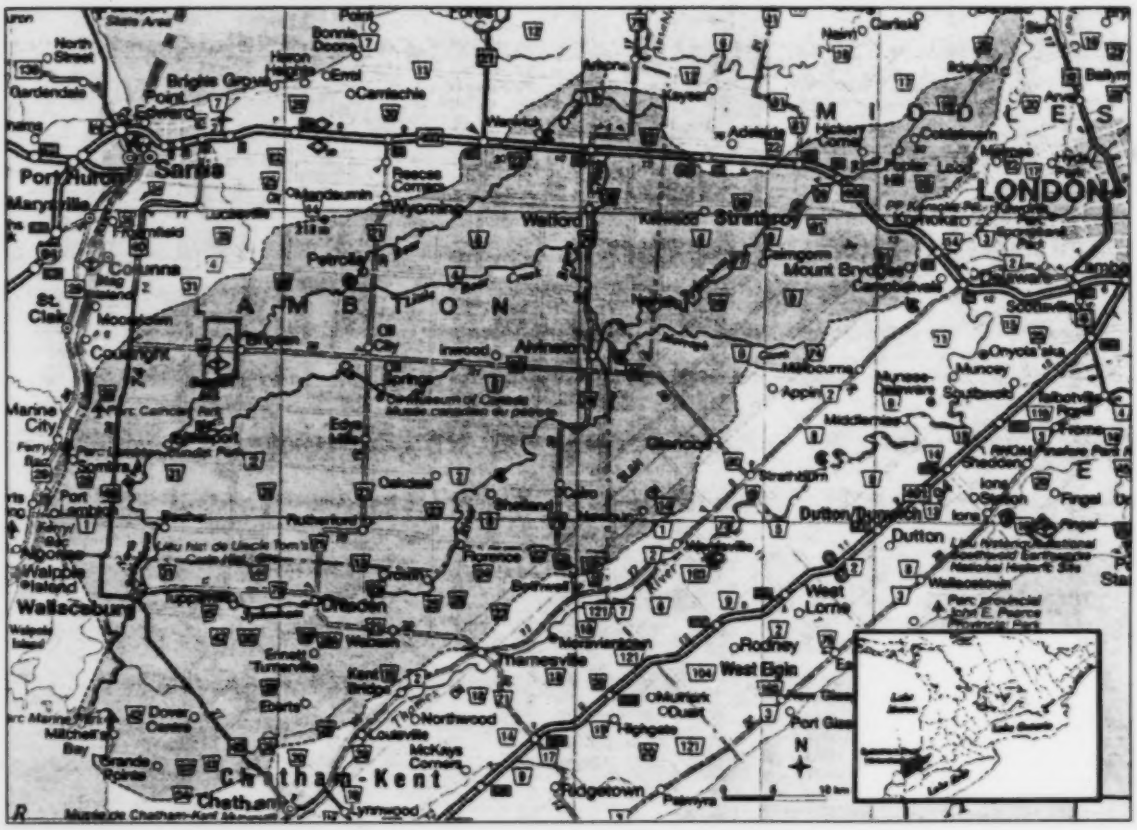
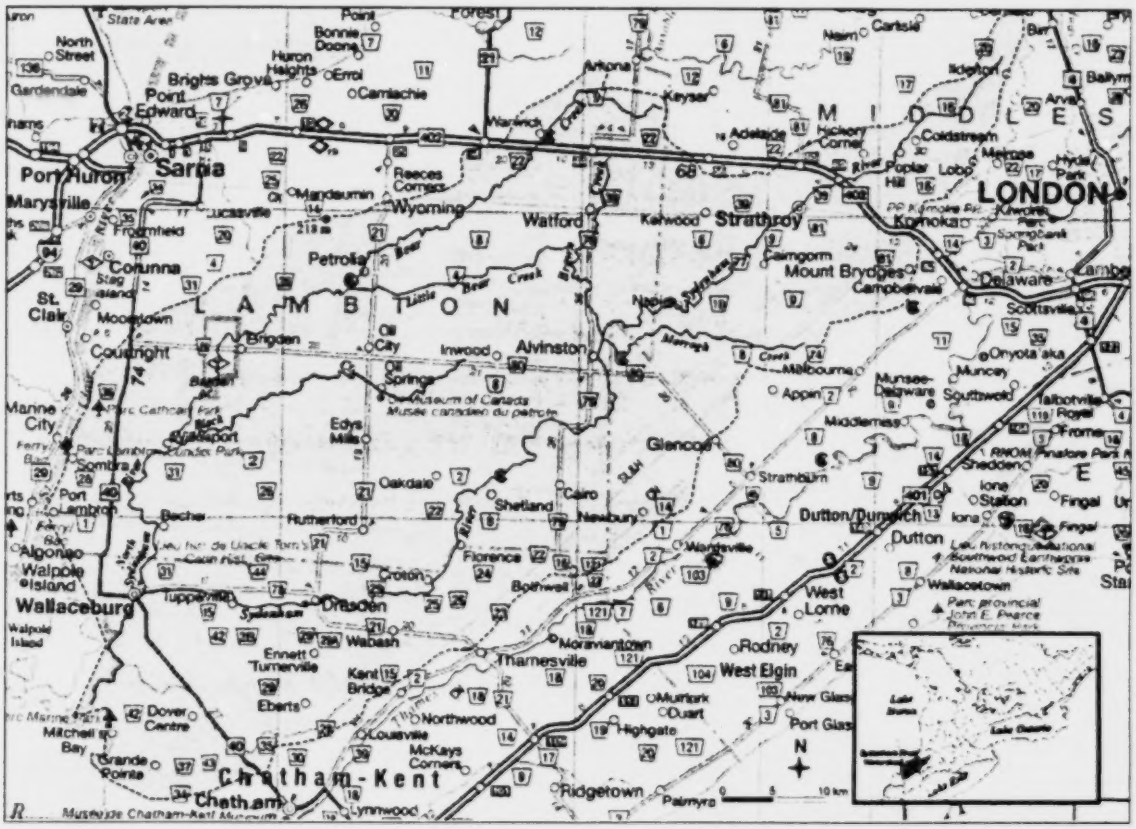


Figure 1
Map of the Sydenham River watershed in southwestern Ontario (inset: map of southern Ontario showing the location of the Sydenham River watershed).



Background

The Sydenham River is a large river system that drains 2725 km^2 of southwestern Ontario into Lake St. Clair. The river has two main branches, the North Sydenham and the East Sydenham, with the confluence located in Wallaceburg. The smaller north branch has two main tributaries, Bear Creek and Black Creek, and drains an area of 617 km^2. The longer East Sydenham River arises from the Lucan moraine near Ilderton and has no large tributaries. About 5 km south of Wallaceburg, the main stem of the river empties into Chenal Ecarté, a channel on the low-lying shore of Lake St. Clair.

The entire Sydenham River watershed is of low relief, with low stream gradients and shallow valleys. Land use throughout the basin is predominantly agricultural, and the human population is small (74 000), with concentrations in the towns of Wallaceburg, Strathroy, and Petrolia. The watershed was historically covered by 70% forest and 30% swamp, but agriculture now covers about 85% of the watershed and is dominated by row cropping. Poor drainage has resulted in the construction of extensive open drain and tile drainage networks. Tile drainage now accounts for over 60% of the total land area of the watershed, and wetlands have been reduced to <1% of the total surface area.

The Sydenham River is a basic, hardwater aquatic environment that is currently nutrient enriched and turbid. The high levels of turbidity and nutrients (particularly phosphorus) are presumably due principally to runoff from farmland. In particular, tile drains facilitate the movement of suspended solids and nutrients from farmland into the river and may significantly contribute to turbidity and nutrient loading. Discharges from sewage treatment plants may also contribute significantly to nutrient loading, while erosion caused by cattle access to the river, low-level crossings, channelization, and narrow bridge spans are also considered to be significant contributors to sediment loading.

Substrate in the watershed varies between the East and North Sydenham rivers. The East Sydenham River has a relatively diverse substrate and associated habitat with well-defined riffles and pools, which create exceptional habitat for native mussels (including all five species listed as Endangered). Habitat in the North Sydenham River is not as diverse and generally has poorly developed channel morphology with few riffles. Any riffles that are present are of poor quality, consisting of tightly packed gravel or small cobbles embedded in clay that do not support endangered mussel species.

The current status of the 14 COSEWIC-listed species at risk in the Sydenham River was assessed by Dextrase et al. (2000). The results of this analysis have been summarized in Table 2. One species was found to be expanding its range (bigmouth buffalo), four species are apparently stable, two species occupy their historic range but may be declining in abundance, two species have a reduced range, and three species may be extirpated from the Sydenham River watershed. Additional surveys are required for most species to confirm these assertions. Detailed information on each species is available in Appendix 1. Although all known data were used in the analysis, the majority of records occur in the past 30–40 years and are often based on presence/absence only (with a limited amount of more recent quantitative data).

To help prioritize species- and location-specific recovery actions, conservation priorities were assigned to all 14 species at risk (Dextrase et al. 2000). Species deemed to be of high conservation priority included all five species of endangered mussels, two threatened fishes, the threatened eastern spiny soft-shell turtle, and one fish species of special concern, the northern madtom, because of its global rarity (see Table 1). All species with a high conservation priority inhabit the East Sydenham River, in particular the stretch of river from just upstream of Alvinston downstream to Dawn Mills (downstream of Croton; see Fig. 1). The Recovery Team has identified this stretch of river as a high priority conservation zone.

Table 2
Population trends for COSEWIC-listed species at risk in the Sydenham River watershed.

Common Name	Population Trend in Sydenham River Watershed[1]
Mussels	
Northern riffleshell	Stable*
Snuffbox	Stable*
Wavy-rayed lampmussel	Extirpated?
Mudpuppy mussel	Stable
Rayed bean	Stable
Fishes	
Eastern sand darter	Declining
Spotted gar	Extirpated?
Northern madtom	Extirpated?
Spotted sucker	Insufficient data
Pugnose minnow	Declining
Blackstripe topminnow	Stable
Greenside darter	Stable
Bigmouth buffalo	Expanding
Turtles	
Eastern spiny softshell	Insufficient data

[1] Stable* = Occupies historic range, but may be declining in abundance.

Threats

Through a synthesis of all available background information, Jacques Whitford Environment Ltd. (2001) determined the principal anthropogenic stresses affecting populations of species at risk in the Sydenham River watershed to be loadings of suspended solids, causing turbidity and siltation, nutrient loads, toxic compounds, thermal effects, and exotic species.

Nutrient loads (phosphorus and nitrogen compounds), primarily from agriculture, are at high levels that present potential risks to aquatic fauna. Total phosphorus levels are particularly high and have consistently exceeded the provincial water quality objective of <0.03 mg/L (MOEE 1994) over the past 30 years. Mean levels of total phosphorus at sites on the East Sydenham River ranged from 0.125 to 0.147 mg/L, with levels as high as 2.9 mg/L reported; mean total phosphorus levels for sites in the North Sydenham basin were about three times higher. Not surprisingly, nitrogen has replaced phosphorus as the limiting nutrient in the system. Although there has been no evidence of blooms of blue-green algae, which can occur when nitrogen is limiting, there is still potential for significant reductions in dissolved oxygen at night. Nutrients enter the system from several sources; however, long-term water quality monitoring data indicate that much of the nutrient load is bound to suspended solids and thus likely originates from farmland. Manure spills also occur and can have significant nutrient-enriching effects, as well as being acutely toxic to fish and invertebrates. Urban areas are not extensive in the watershed but contribute to total nutrient loadings through municipal wastewater discharges. Loadings from domestic septic systems may also be significant.

Pesticides (herbicides, insecticides, etc.) associated with agricultural practices and urban areas run off into the Sydenham River watershed and could have a significant impact on species at risk. Roads and urban areas can also contribute significant contaminants to waterways, including oil and grease, heavy metals, and chlorides. Until about 1990, chloride levels in particular were high enough in the North Sydenham River to cause significant biological impairment. Chloride concentrations at all three monitoring sites in the north branch were as high as 1000 mg/L between 1967 and 1990, often exceeding 200 mg/L, which is the concentration estimated to cause long-term toxicity to some freshwater organisms (Evans and Frick 2002). Prior to 1990, saline formation waters produced from local oil wells were released to surface waters in the North Sydenham watershed. Since then, these waters have been

injected back into the ground, and chloride concentrations have declined to levels similar to those in the East Sydenham River (10–50 mg/L). The impacts of high chloride concentrations on species at risk in the North Sydenham watershed are unknown.

Thermal effects on the river occur through three general pathways. First, the loss of riparian zones in agricultural lands increases solar radiation reaching the stream surface. Although there are riparian corridors along the Sydenham River and its tributaries, these vary in width and quality, and there are extensive reaches lacking riparian zones. Reservoirs also increase temperatures by increasing surface area and by water holding. There are six significant reservoirs in this watershed at conservation areas in Strathroy, Coldstream, Petrolia, Alvinston, Henderson, and Warwick. Finally, global climate change is expected (among other disruptions) to cause an increase in surface water temperatures in southern Ontario (H. Hengeveld, Environment Canada, personal communication). Although the Sydenham River supports a warm-water environment, and many species are tolerant of warm water, higher water temperatures may be an added stress for some. Increased water temperatures may also increase algal growths, which could result in reductions in dissolved oxygen levels at night.

Exotic species may currently be exerting negative effects on the species at risk in the Sydenham River. Common carp (*Cyprinus carpio*) are abundant throughout the watershed and are the exotic species most likely to be adversely affecting sensitive species. Although they can potentially consume juvenile unionid mussels, their uprooting of plants and feeding on sediment-associated fauna can significantly increase turbidity, which is likely a far greater impact. Zebra mussels (*Dreissena polymorpha*) have decimated native mussel populations in waters of the Great Lakes basin. If zebra mussels become established in upstream reservoirs of the Sydenham River, the impact on the unique mussel diversity of the river would be devastating. Currently, zebra mussels are found only in the lower reaches of the river, where their impact on species at risk is believed to be minimal. The potential for the invasive round goby (*Neogobius melanostomus*) to impact species at risk if it were to colonize riverine habitat in the Sydenham River is unknown, but could be substantial. The round goby has decimated populations of mottled sculpins (*Cottus bairdi*) and possibly logperch (*Percina caprodes*) in the St. Clair River (French and Jude 2001). This species may pose a direct threat to fish species at risk and an indirect threat to mussel species if host fish populations are affected. The round goby has not yet been documented from the Sydenham River, but it is abundant in Lake St. Clair and its connecting channels (Ray and Corkum 2001). This species has recently been confirmed from Running Creek in Wallaceburg near the mouth of the Sydenham River (E. Holm, Royal Ontario Museum, personal communication). Additional introductions of exotic species into the Sydenham River are most likely to occur through the movement of boats from infested areas, the use of live bait fish, or the natural invasion of species introduced into the Great Lakes basin.

Loadings of suspended solids and associated turbidity levels throughout the watershed are high, although there is some spatial variation. Conditions are generally worse in the North Sydenham, where turbidity is about twice that of the east branch, and sediment fans have been observed at the mouths of tributaries. Concentrations of suspended solids typically range between 50 and 90 mg/L in the North Sydenham, but have reached levels as high as 900 mg/L on occasion. Levels of suspended solids also increase somewhat in a downstream direction in both branches. Agriculture, which covers about 85% of the watershed, is the principal source of the sediments, either by overland flow or via tile drains. The loss of riparian zones due to direct cattle access and plowing to the edge of the stream is significant. Riparian zones are important for bank stabilization and interception of nutrients and suspended solids from overland runoff. Without riparian zones, banks can become unstable and erode and further contribute sediment. Other sources include sediment eroded from channelized sections of stream, poorly constructed bridge crossings, and reaches downstream of dams.

Although nutrient loads, toxic compounds, heat, and exotic species may be contributing stresses on the system, loading of suspended solids causing turbidity and siltation is presumed to be the primary limiting factor for most species at risk. The majority of rare fish and mussel species depend on clean gravel and sand riffles and are particularly vulnerable to siltation. Siltation can bury and smother mussels as well as interfere with feeding and the visibility of display mechanisms (lures, conglutinates) required for successful reproduction. Increases in turbidity can also have detrimental impacts on species, like the pugnose minnow, that rely on dense growths of submerged macrophytes (which would be reduced due to high turbidities).

All identified threats are widespread and chronic in nature (Table 3) and are believed to be the key stresses driving historical declines of many sensitive aquatic species. Sediment and nutrient loadings along with toxic compounds are mainly associated with agricultural runoff and therefore tend to be somewhat episodic in nature, with levels peaking shortly after rainfall events. Although sediment loading has been identified as the primary limiting factor for most species at risk, it is important to recognize the inherent complexity of aquatic ecosystems and that population declines are, in most cases, likely a result of the cumulative impacts of many interacting anthropogenic stresses. It is unlikely that any of the five threat factors identified have been diagnosed and tested empirically as driving declines for individual species; however, these threats are strongly supported in the literature as having key impacts on aquatic ecosystems in general.

Table 3
Key stresses to the Sydenham River aquatic ecosystem[1]

Threat	Relative Impact	Spatial Nature	Temporal Nature	Certainty of Effect
Siltation and turbidity	Predominant	Widespread	Chronic, episodic	Probable
Nutrient loads	Contributing	Widespread	Chronic, episodic	Probable
Toxic compounds	Contributing	Widespread	Chronic, episodic	Probable
Thermal effects	Contributing	Widespread	Chronic	Probable
Exotic species	Contributing	Widespread	Chronic	Probable

[1] Additional detail on specific causes can be found in Table 7 of Jacques Whitford Environment Ltd. (2001).

Specific threats are identified in the original COSEWIC status reports for each species (Appendix 3) and are summarized in the species-specific background information section of this Strategy (Appendix 1).

I. OVERALL RECOVERY OF THE SYDENHAM RIVER ECOSYSTEM

Recovery Goal

The long-term goal of this Recovery Strategy is to sustain and enhance the native aquatic communities of the Sydenham River through an ecosystem approach that focuses on species at risk.

Short-Term Recovery Objectives

The short-term recovery objectives to be addressed over the next five years are as follows:

I. Maintain the current geographical distributions and abundances of species at risk.
II. Improve water and habitat quality by reducing sediment loads and nutrient and chemical inputs and ensuring that the base flow rate is maintained.
III. Reduce the risk of the introduction of exotic species in the watershed.
IV. Establish a broad-based monitoring program that assesses the physical, chemical, and biological characteristics of the system.
V. Promote stewardship by encouraging a sense of public ownership and involvement among landowners, stakeholders, those working in the watershed, and other interested citizens.
VI. Generate awareness regarding the Sydenham River and the significance of its natural heritage.
VII. Enhance the understanding of key aspects of the Sydenham River ecosystem that will lead to further refinement and prioritization of essential recovery actions (an adaptive management approach).

Overall Strategies/Approaches to Recovery

The overall strategies/approaches to recovery have been organized into the four categories recommended by the Recovery Team for Recovery Action Groups (RAGs) — Management, Stewardship, Research and Monitoring, and Community Awareness and Outreach. It should be noted that these categories are not absolute in nature, and successful implementation of some strategies will require the coordinated efforts of other RAGs. A narrative is included at the end of each section when further explanation is warranted.

A) Management

Priority	Objective No.	Broad Approach/ Strategy	Specific Steps	Anticipated Effect	Cost Estimates
Urgent	I	A1: Habitat mapping	Identify and map habitat for species at risk based on existing information and ensure that habitat information is transferred to appropriate planning and review agencies; update mapping as new information becomes available.	Will allow for the protection of habitat during the planning and review of proposals for development and works in and adjacent to the river.	In-kind
Urgent	I & VI	A2: Awareness	Hold one-day workshops with municipal staff and planning and review agencies.	Will increase awareness of agencies that are making decisions that could affect habitat quality in the river.	$5,000
Urgent	I	A3: Drainage	Work with drainage superintendents, drainage engineers, and contractors to limit the effects of drainage works on habitat for species at risk.	Will protect habitat that may be impacted by drain maintenance activities.	In-kind
Urgent	I & VII	A4: Habitat mapping	Map known habitats of terrestrial species at risk within 100 m of the river; communicate with other recovery teams and conservation groups working in the same area.	Will ensure that habitat improvement projects will not inadvertently affect habitats of other species at risk.	In-kind
Necessary	I	A5: Policy and legislation	Provide advice to provincial and federal governments on effective legal and policy approaches for protection of endangered and threatened species.	Will increase legal and policy protection for endangered and threatened species and their habitats and elevate the profile of these species.	N/A
Necessary	I & II	A6: Incentives - habitat protection	Work with Ontario Ministry of Natural Resources (OMNR) to investigate riparian habitat protection incentives that could be developed under the Conservation Land Tax Incentive Program (CLTIP).	If riparian habitats are included under the CLTIP, many landowners adjacent to the Sydenham River would be eligible for tax relief.	In-kind
Necessary	I, II, & V	A7: Bridges/ road crossings	Ensure that the design of future bridges and road crossings (or improvements to existing structures) respects natural stream geomorphology.	Will ensure that new bridges and crossings do not cause excessive erosion and scouring.	In-kind
Necessary	I	A8: Municipal planning	Encourage municipal planning authorities to incorporate the recovery goal in their official plans and to consider a natural heritage overlay schedule indicating the habitats of species at risk.	Will provide additional protection for species at risk when development proposals are planned and reviewed.	N/A
Necessary	I	A9: Baitfish	Work with bait harvesters and the Bait Association of Ontario to protect and monitor fishes at risk that are currently legal baitfish.	Will protect fishes at risk from incidental harvest.	N/A

A5: Policy and legislation — None of the aquatic species at risk that occur in the Sydenham River are currently regulated under Ontario's Endangered Species Act. If the proposed federal Species At Risk Act becomes law, then it is likely that all of the threatened and endangered species addressed in the Recovery Strategy (five mussels, two fishes, and one turtle) will be regulated under this Act. Regulation is important to provide legal protection to the species and their habitats and to raise the profile of these species. The definition of habitats for regulated species is also extremely important. The Recovery Strategy defines habitats for mussels and fish as the areas below the top of bank only. It is important that this information be conveyed to Environment Canada and OMNR for the purposes of habitat mapping for legal purposes.

A6: Incentives – habitat protection — Landowners who currently provide protection for riparian habitats are not eligible for tax relief under the provincial CLTIP unless there is an easement granted to a non-profit conservation organization. The Recovery Team will approach OMNR regarding the possibility of changing eligibility requirements for this program. CLTIP and other incentive programs will be promoted through the community awareness and outreach approaches.

B) Stewardship (Habitat Improvement)

The majority of the following approaches for habitat improvement would be considered "best management practices" (BMPs). This is not intended to be a comprehensive list of BMPs, but includes many that would be most relevant to the recovery of the Sydenham River. Additional BMPs would be covered under Environmental Farm Plans and Nutrient Management Plans (see B10: Farm planning).

Priority	Objective No.	Broad Approach/ Strategy	Specific Steps	Anticipated Effect	Cost Estimates
Urgent	I, II, & V	B1: Riparian buffers	Establish riparian buffer zones through naturalization and plantings of native species. Encourage participation of private landowners through financial incentives.	Will improve water quality by reducing bank erosion and intercepting overland runoff; shading from riparian vegetation will also help reduce high water temperatures.	$50,000 per year + in-kind
Urgent	I, II, & V	B2: Herd management	Reduce livestock access to the river through passive exclusion and fencing where appropriate. Encourage participation of farmers through financial incentives.	Will improve water quality by reducing bank erosion and reducing nutrient input.	$50,000 per year + in-kind
Urgent	I, II, & V	B3: Livestock waste management	Establish manure storage and runoff collection systems where necessary.	Will improve water quality by reducing nutrient input.	$100,000 per year (+ in-kind)
Urgent	I, II, & V	B4: Low water crossings	Work with landowners to repair or remove low water crossings that are damming water and contributing to erosion and sedimentation.	Will improve water quality by reducing in-stream erosion caused by improperly installed low water crossings.	$100,000
Urgent	I, II, & V	B5: Tile drainage	Encourage the implementation of BMPs to reduce sediment and nutrient inputs from tile drains.	Will improve water quality.	N/A
Necessary	I, II, & V	B6: Conservation tillage	Encourage conservation tillage by offering financial incentives to first-time practitioners.	Will improve water quality by reducing overland runoff and wind erosion.	$100,000
Necessary	I, II, & V	B7: Tile drainage	Establish demonstration projects involving the installation of header tiles and silt traps on tile drain systems.	Will improve water quality by reducing sediment and nutrient inputs from tile drains.	$50,000
Beneficial	I, II, & V	B8: Agricultural drains	Encourage the installation of sediment traps in agricultural drains (a demonstration project has been initiated on the Humphrey Creek drain by Fisheries and Oceans Canada).	Will improve habitat and water quality by reducing sediment inputs to the river.	TBD
Beneficial	I, II, & V	B9: Soil testing	Encourage soil testing to allow precise applications of fertilizer and pesticides.	Will improve water quality by reducing nutrient loading from agricultural lands.	TBD
Beneficial	I & V	B10: Farm planning	Encourage the development of Environmental Farm Plans and Nutrient Management Plans.	Will provide for additional habitat protection (reduction in sediment and nutrient loadings) from ongoing farming activities.	N/A
Beneficial	I, II, & V	B11: Sewage treatment (rural)	Work with landowners to upgrade faulty septic systems.	Will improve water quality by reducing nutrient inputs from rural septic systems.	TBD
Beneficial	II	B12: Habitat improvement – wetland creation	Investigate the feasibility of reestablishing wetlands in appropriate locations.	Will help regain some wetland function throughout the watershed, contributing to sediment control, low flow augmentation, and groundwater recharge.	$75,000

Efforts to reduce sedimentation through improved land management practices and riparian rehabilitation will provide benefits to a large number of the species at risk. Any such efforts should recognize that "natural" erosion of sand banks is particularly important in maintaining habitats for the eastern sand darter and eastern spiny softshell and may benefit other fish and mussel species that use sand substrates in the river. In particular, the eastern spiny softshell requires vegetation-free, sandy nesting areas; therefore, hardening of the shoreline and the establishment of vegetation in these areas should not be undertaken.

In order to increase the cost-effectiveness of habitat improvement, implementation of these broad approaches/strategies will be prioritized geographically. The stretch of the East Sydenham River from just upstream of Alvinston downstream to Dawn Mills has been identified as a high conservation priority zone, and habitat improvement projects benefiting this section of the river should be given highest priority.

B5: Tile drainage — Since sediments and nutrients delivered through tile drainage are not mitigated through riparian vegetation, the implementation of BMPs for these drainage systems should be specifically encouraged to reduce their impacts. For example, in some areas, tile drainage may have been installed unnecessarily where steeper slopes or coarser soils exist, and it may be possible to remove or plug some drains.

C) Research and Monitoring

Priority	Objective No.	Broad Approach/ Strategy	Specific Steps	Anticipated Effect	Cost Estimates
Urgent	IV & VII	C1: Monitoring program – species at risk	Establish index stations for species at risk (surveyed once every 3 years); include in-stream habitat assessments.	Track changes in the population ranges and densities of species at risk and overall mussel and fish community structure; will also allow for the incidental detection of exotics.	$70,000
Urgent	IV & VII	C2: Monitoring program – water quality/quantity and benthics	Reinstate a water quality and benthic monitoring program.	Track changes in water quality (chemical and biological response) and quantity. Will assist with determining measurable water quality targets.	$30,000 per year
Urgent	I, III, & VII	C3: Sediment and nutrient modelling	Conduct research required on the sources of nutrients and sediments.	Will result in the determination and quantification of key sources of nutrients and sediments to allow the prioritization of restoration actions. Will assist with determining measurable water quality targets.	$50,000
Urgent	I, II, V, & VII	C4: Sewage treatment (municipal)	Evaluate nutrient contributions from municipal sewage treatment plants (STPs) and work with municipalities to reduce inputs as appropriate.	Will improve water quality by determining relative nutrient contributions of STPs and reducing inputs where necessary.	TBD
Urgent	II & VII	C5: Riparian inventory	Conduct an inventory of riparian buffers and their health.	Will allow for the identification of areas that require most attention and will provide for long-term monitoring.	$20,000
Necessary	II	C6: Base flow	Establish a research program that will address knowledge gaps related to trends and sources of base flow.	Will allow for the identification of key drivers of base flow, protection techniques, and base flow target levels.	TBD
Necessary	III & IV	C7: Exotic species – distribution and impacts	Investigate the distribution and abundance of exotic species, and implement controls if feasible.	Will identify if control efforts are necessary. Control of common carp may result in lower levels of suspended solids in the water column.	TBD
Necessary	I & VII	C8: Habitat mapping	Field work to further refine and map important habitat features.	Will improve ability to protect important habitat features.	$10,000
Beneficial	II & VII	C9: In-stream improvements	Investigate the feasibility of increasing bank roughness at select locations in the watershed.	Will improve water quality by reducing bank erosion and aiding in sediment transport. Will increase habitat complexity and species diversity.	TBD
Beneficial	I & VII	C10: In-stream improvements	Investigate the feasibility of improving substrate of riffle areas in Bear Creek. Monitor the results of any alterations made.	Will improve habitat conditions for species at risk in the North Sydenham River.	TBD

C1 and C2: Monitoring program — A routine monitoring program that quantitatively tracks changes in the aquatic community and water quality is required to determine the progress of recovery efforts throughout the watershed. Such a program has many benefits, including tracking changes in the range and population densities of species at risk, tracking changes in the overall fish and mussel community, including the invasion of exotic species, and

assessing changes in water quality (both chemically and biologically through benthic invertebrate surveys). Monitoring data should be summarized every 3 years and would be essential for the adaptive management approach suggested for recovery of the watershed. The monitoring program should strive to:

- Establish index stations for fish and mussel species at risk throughout areas of recovery habitat using quantitative species-specific sampling protocols (monitor once every 3 years). Complete fish and mussel community information, including population demographics, will be collected, as well as habitat parameters. Non-destructive sampling methods will be used.
- Repeat population and habitat surveys for the eastern spiny softshell in the East and North Sydenham rivers every 5 years. Habitat assessments will serve to determine any changes in the condition of previously known sites and record any new sites along the river.
- Reestablish Ontario Ministry of Environment and Energy (MOEE) water quality sampling throughout the watershed. Sampling should be conducted monthly at a total of about 20 sites (including seven long-term MOEE sites) and at index stations where possible. Information would be collected on the seven key parameters identified by Di Maio (2000), and guidance from MOEE water quality experts on additional parameters and sampling techniques should be sought.
- Complement water quality sites with ongoing benthic invertebrate sampling (surveys have been initiated at 30 sites throughout the watershed). Annual benthic monitoring will help interpret water quality data in a biologically meaningful way.

C3: Sediment and nutrient modelling — Sources of sediments and nutrients should be more fully quantified for the basin on a sub-watershed scale. This would involve the development of a model that incorporates loadings of suspended solids from tile drainage, overland flow, and bank erosion, as well as accounting for soil erodibility and the quality of riparian zones. The model should also incorporate non-point source fertilizers, sewage treatment plants, and rural septic systems, as well as manure, and help determine the relative contributions from each. In addition, there has been no quantification of total drain area within sub-watersheds. Straightened drains are a potentially significant source of release of sediment to the system and should be incorporated into the model as well. The model could be improved by field measurements and be used to help prioritize actions to reduce sediment and nutrient inputs.

C5: Riparian inventory — The extent and quality of riparian vegetation throughout the East Sydenham watershed (highest priority zone) should be assessed in order to guide and prioritize restoration activities. The inventory could be conducted most cost effectively through the creation of a geographic information system coverage using existing digital information, including recent classified satellite data and infrared aerial photos. Tile drainage mapping should be included in the analysis to further prioritize areas for restoration. Tile drainage, which is subsurface, allows sediment- and nutrient-laden waters to bypass riparian vegetation, thereby reducing the effectiveness of the vegetation in reducing loadings of nutrients and sediments to the watercourse. As such, riparian restoration zones that are not adjacent to tile-drained lands have the greatest buffering capacity and will be given highest priority for restoration. The completion of an inventory would allow goals to be set for the reestablishment of riparian zones within the East Sydenham priority zone, and such an inventory would also serve as a baseline for monitoring changes in the quantity and quality of riparian vegetation.

C6: Base flow — River base flows may be particularly important to the survival of many species of fish and mussels. For example, base flows could be a limiting factor, reducing available habitat during the most stressful summer months. Research into base flows could help address the question of whether base flows have declined over time and what potential impact increased water taking for irrigation might have during periods of summer drought. The determination of the critical base flow required for species survival would help agencies involved in the management of water resources set base flow targets. The identification of important sources of base flow to the river (such as areas of groundwater upwelling) would facilitate their protection. Finally, a firm understanding of base flow patterns may also help determine the impacts of historical wetland loss and provide guidance regarding the importance of reestablishing wetlands throughout the watershed.

Additional research – Only the highest-priority overall research needs are identified in the Approaches table above. Additional overall research requirements are identified in the Knowledge Gaps section, and research needs for individual species are identified in the background information section (Appendix 1). The Research and Monitoring RAG will need to review all of these research requirements and establish priorities for their implementation, to ensure that priority approaches can be implemented in a timely fashion.

D) Community Awareness and Outreach

Priority	Objective No.	Broad Approach/ Strategy	Specific Steps	Anticipated Effect	Cost Estimates
Necessary	III, IV, & V	D1: Increase public awareness	Establish a public outreach RAG; develop a communications strategy.	Improve understanding among general public, farmers, watershed employees, and other stakeholders to stimulate community support for recovery efforts.	TBD
Urgent	III	D2: Exotic species	Post signage at access points, conservation areas, marinas, and bait/tackle shops in the region with messages to boaters and anglers regarding the spread of exotic species. Include exotic species as part of the communications strategy.	Will help reduce the risk of the introduction of zebra mussels and other exotic species.	$2,000
Necessary	I, II, & V	D3: Incentives – habitat protection	Make landowners aware of existing tax incentive programs for conservation lands (Ecological Gifts Program, easements, CLTIP).	Will increase the number of landowners participating in incentive programs that protect habitat.	N/A

D1: Increase public awareness — Due to the importance of public awareness and associated initiatives, a RAG was formed to coordinate awareness and outreach activities. This group will develop a communications strategy that raises awareness, promotes private land stewardship, and helps garner public support for implementation of recovery actions. The strategy will identify target audiences (e.g., school groups, the general public, environmental groups, the farming community, and other stakeholders) and appropriate messages and media for each audience. Awareness products that should be considered include a Sydenham River Landowner Handbook that promotes BMPs and raises awareness regarding species at risk and incentive programs, a biannual newsletter, an enhanced web site, and products that communicate applied science to specific audiences. Evaluation measures will be included in the communications strategy.

Recovery and Survival Habitat

Recovery and survival habitats are described for each individual species in subsequent sections of the Strategy (Appendix 1). As a general rule, survival habitat was defined as those reaches that are currently occupied by the species in question, while recovery habitat was defined as those reaches currently and historically occupied by the species. In a few cases, recovery and survival habitat are equivalent, as there has been no known range retraction for some species. It should be noted here that the majority of data for these species have been collected in the past 30–40 years. Therefore, if reductions in range have occurred previous to this, our definition of recovery habitat (as defined above) would be conservative.

The Recovery Team discussed the possibility of including riparian areas (e.g., 30-m buffer zone) in the identification of survival or recovery habitat. The condition of the riparian zone has a great influence on the in-stream habitats on which the species at risk depend. However, all of the species are entirely aquatic with the exception of the eastern spiny softshell, which requires nesting and basking habitat. Therefore, recovery and survival habitats for fishes and mussels are defined in this Strategy as areas below the "top of bank" only. Much of the recovery work will concentrate on improving the condition of the Sydenham River's riparian zone to improve the in-stream habitats.

Actions Already Completed or Under Way

Sydenham River Stewardship Initiative (SRSI) — This initiative was established in 2000 to provide landowners with financial and technical support to assist them with stewardship on their lands. Partners involved with the implementation of this program include the St. Clair Region Conservation Authority and the local stewardship councils of Kent, Lambton, and Middlesex counties. This initiative has received ongoing funding from the Government of Canada's Habitat Stewardship Program for Species at Risk; it received $88,000 in funding for the first year. The goal of this initiative is to improve water quality and aid the recovery of fish and mussel species at risk in the Sydenham River by minimizing non-point source pollution and enhancing riparian habitats. In total, eight projects were funded in 2000, including wetland enhancement, riparian plantings of trees, shrubs, and tallgrass prairie species, conservation tillage equipment, and the establishment of a demonstration site that implements rotational grazing, warm-season pasturing, and alternative watering systems to discourage cattle access to the watercourse.

Projects were selected through the use of priority-setting guidelines developed in consultation with the Recovery Team. In 2001, a total of $152,000 in Habitat Stewardship Program funding was received for similar stewardship projects, and a further $226,500 was committed in 2002. The SRSI has been very effective at raising the awareness and support of the agricultural community for improved land stewardship for the benefit of aquatic species at risk.

Public awareness and consultation — An awareness poster entitled "Aquatic Species at Risk in the Sydenham River Watershed" was produced in June 2001 by the Sydenham River Recovery Team. A total of 5000 English and 1000 French posters are currently being distributed by the St. Clair Region Conservation Authority, local stewardship councils, and other agencies participating on the Recovery Team. Signage to increase awareness for aquatic species at risk and invasive species prevention was erected at public river access points. A web site for the Sydenham River recovery project has been developed (http://sydenhamriver.on.ca), which provides a wide range of information on COSEWIC-listed aquatic species, background reports, awareness materials, answers to frequently asked questions, as well as stewardship opportunities and contacts. The web site is updated regularly with current recovery efforts and events. An outreach and education program on aquatic species at risk for area schools was developed in 2001 and will be delivered to 1600 students in 2002–2003.

Public consultation has included one meeting in January 2001 and three workshops with landowners and stakeholders in June 2001. The initial public meeting in January was a general information session with presentations and displays on the significance of the river and its species, the recovery planning process, and stewardship activities. The latter workshops in June were held at three locations throughout the watershed in order to receive input from the public on the development of the Recovery Strategy. Two public meetings were held in the fall of 2001 to invite comment on the first draft of the Recovery Strategy. The Strategy was also posted on the provincial Environmental Bill of Rights web site in January 2002 for a 30-day public comment period. All comments received were considered by the Recovery Team, and many improvements were made to the Strategy as a result. The many workshops and meetings were successful in increasing public awareness as well as engaging landowners in the recovery planning process.

A number of informative articles about the project also appeared in local newspapers. A mailing list of interested participants has been maintained for future public involvement in the implementation process.

Recent surveys and reports — Recent reports have been prepared on fish sampling in the lower East Sydenham River (Holm 2001) and on mussel communities in the Sydenham River (Metcalfe-Smith et al., in press). Research to determine fish hosts for endangered mussel species is ongoing at the University of Guelph, and a report is being prepared on changes in fish communities in the Sydenham River over time by Environment Canada. Five mussel monitoring index stations have been established by Environment Canada, and additional sites will be added during the 2002 field season. Fisheries and Oceans Canada has initiated a 2-year graduate project on fish species at risk in the Sydenham River. The main objective of this project is to develop a standardized protocol for assessing and monitoring fish species at risk and their habitat. This project will also be used to establish long-term monitoring index stations for fishes.

Knowledge Gaps

This section identifies important knowledge gaps for the watershed that do not appear in the overall strategies/approaches section. Note that species-specific knowledge gaps for each species at risk are included in Appendix 1.

River flow rates — Although research on base flows was already identified in the section on research and monitoring strategies, further investigation is required surrounding issues of flow rates in the watershed. Parish Geomorphic Ltd. (2000) examined long-term flow data and noted a declining trend in maximum instantaneous flow rates. Such changes have been attributed to the establishment of dams and changing precipitation patterns, and these potential factors need to be investigated further. Insight into precipitation patterns can be provided with data from Environment Canada. Other relevant questions about flow rates include the following: What impact on the aquatic community could be expected from future climate change combined with an increased demand for crop irrigation? How substantial is the current water take for agriculture? What is the impact on the water budget from the recent piping of water from Lake Huron for domestic use within the Sydenham watershed? To what extent are sewage treatment plants augmenting summer low flows? Finally, what are the effects of farm drainage and expanding urbanization on flow rates?

Dams — The functions of the St. Clair Region Conservation Authority's dams and reservoirs should be reviewed to determine if there is potential for their renaturalization or for modification to their operation. Dams disrupt natural sediment movement, causing sedimentation upstream and erosion downstream, reduce maximum instantaneous flow rates, raise stream temperatures through solar warming, and present barriers to the upstream movement of fish. Dams in Strathroy and Coldstream on the East Sydenham River may be particularly significant.

Local historical knowledge — Due to the lack of historical data on water quality and general river conditions, long-time community members, including aboriginal groups, could be interviewed to establish anecdotal accounts. Often such information can prove invaluable in helping to establish historical conditions that may be overlooked otherwise.

Other rare aquatic species — The distributions of rare dragonflies and damselflies (*Odonata*) and other rare invertebrates (e.g., mayflies (*Ephemeroptera*), stoneflies (*Plecoptera*), and beetles (*Coleoptera*)) throughout the Sydenham River watershed should be determined. Although it is likely that there are rare invertebrates from many different invertebrate taxa, only rare species of unionid mussels and odonates have been identified to date.

Quantitative sampling protocols — Quantitative sampling protocols for all species at risk should be developed for use at index stations. Traditional survey techniques are often inadequate for sampling species at risk because of their rarity and their specialized habitat preferences. Standardized protocols are required so that reliable information is available to provide defensible trend-through-time data. General protocols have been developed for species of unionid mussels, but not for fishes. Protocols developed by OMNR are available for wadeable streams, but most reaches of interest in the Sydenham River are in non-wadeable sections. Therefore, the development of standardized protocols for collecting fish over a variety of depth conditions is a priority. Fish sampling protocols should be non-destructive and designed to determine community composition, species abundance, and population demographics.

Current land use — Current land use/management changes need to be determined. The most recent land use information is from 1983 (Nelson 2001), and we have not determined what changes may have taken place since then. For example, there has been a substantial conversion of conventional tillage to conservation tillage on agricultural lands, but this fact has not been quantified. Such information could have an impact on recovery strategies.

Pesticide impacts — The potential impact of pesticides on aquatic species from intensive agriculture throughout the watershed should be investigated. We have no knowledge of pesticide impacts (either alone or synergistically) on individual species at risk. Pesticide use data are available from the Ontario Ministry of Agriculture and Food since

the 1970s, and there is a very limited number of pesticide data available from the MOEE's water quality monitoring stations on the Sydenham River. A limited amount of sampling conducted near Wallaceburg by Environment Canada in 1998 revealed detectable levels of three herbicides: metolachlor, dicamba, and atrazine (J. Stuger, Environment Canada, personal communication). Additional pesticide sampling in the high-priority section of the East Sydenham River could help determine if concentrations of some pesticides reach concentrations that are likely to affect aquatic organisms.

High chloride levels — If possible, the impacts of the historically high chloride levels found in the North Sydenham watershed on the aquatic community should be determined.

Tile drainage — The nature of suspended solids received from tile drainage in the Sydenham River watershed has not been characterized. Further research in this area could help quantify the relative contribution of sediment and associated turbidity from tile drainage versus other sources and would provide input into the sediment and nutrient model proposed in the overall strategies/approaches section.

Links to Existing Management Plans

The following management plans and strategies have been identified as relevant to this Recovery Strategy. Where necessary, implementation efforts will require harmonization with these plans (refer to the Overall Strategies/Approaches to Recovery section for specific examples):

- Sydenham River Watershed Strategy (St. Clair Region Conservation Authority)
- Official Plans (Kent, Lambton, and Middlesex counties; municipal)
- St. Clair River Remedial Action Plan — study area includes the North Sydenham River, Bear Creek, and Black Creek sub-watersheds
- Chatham District Fisheries Management Plan (OMNR)
- National Recovery Plan for the Eastern Spiny Softshell (draft strategy, unpublished)
- Tallgrass Prairie Restoration Plan
- Rare Trees of the Sydenham River (OMNR/St. Clair Region Conservation Authority draft strategy)
- Lake Erie Lake-wide Management Plan – Biodiversity Strategy
- Lake St. Clair and St. Clair River Management Plan (draft)

Recovery Action Groups (RAGs) and Recovery Action Plans (RAPs)

In the fall of 2001, the Recovery Team sought input on the formation of RAGs from various identified stakeholders. Following these discussions, the Recovery Team facilitated the formation of four RAGs in February 2002 to implement the Recovery Strategy. RAGs are responsible for drafting their own RAPs using the corresponding strategies/approaches section of this Recovery Strategy. Draft RAPs from the four groups were completed in the fall of 2002. The successful implementation of some strategies will require the coordinated efforts of more than one RAG, and this will be accomplished through overall management/coordination by the Recovery Team.

It is important to note that the RAGs are intended to provide a forum for existing agencies and community groups to discuss and coordinate approaches to implementation; the actual implementation of recovery actions will remain the responsibility of existing groups and agencies. The functions of the four RAGs are identified below:

1. Management RAG — This group will attend to matters related to the management of the watershed and will liaise with various levels of government as required by the Recovery Strategy. The management RAG will be responsible for such matters as transferring information (such as habitat mapping) to planning and review agencies, holding workshops to ensure habitat protection, and attending to all legislative matters. The membership of this RAG includes Recovery Team members, representatives from management agencies in the watershed, and landowners.

2. Stewardship RAG — This group will be responsible for the promotion and delivery of on-the-ground land stewardship that will contribute to the improvement of water and habitat quality as identified in the Recovery Strategy. The group will assist landowners financially through funding programs such as the Government of Canada's Habitat Stewardship Program for Species at Risk. The core of this RAG has already been formed through the Sydenham River Stewardship Initiative, which includes the three county stewardship councils (Kent, Lambton, and Middlesex) and the St. Clair Region Conservation Authority.
3. Research and Monitoring RAG — This group will be responsible for the science component of the Recovery Strategy, including the monitoring program, species inventories and research (identified for each species in Appendix 1), evaluation projects, sediment modelling, and other research areas identified as "knowledge gaps" for the watershed. The group is largely composed of Recovery Team members who are currently conducting research or monitoring activities on the Sydenham River as well as others outside the Recovery Team (i.e., water quality and benthic invertebrate experts, university faculty interested in graduate projects, etc.).
4. Community Awareness and Outreach RAG — This group will be responsible for developing and implementing a broad-based communications strategy for the recovery of aquatic species at risk in the Sydenham River. The group will be responsible for raising awareness among landowners, farmers, and other stakeholders in the watershed through such means as public presentations, publications, signage, and web sites. The community awareness and outreach RAG will work closely with the stewardship RAG at garnering community support for recovery work in the watershed. The membership of this RAG is composed of individuals from the St. Clair Region Conservation Authority, the Recovery Team, and interested members of the community.

Potential Impacts of Recovery Strategy on Other Species/Ecological Processes

The goal of this Recovery Strategy recognizes the importance of the entire aquatic community. Through an ecosystem approach to improving water quality in the system, habitat improvements should allow most native species to maintain or increase existing populations. Some common species such as common carp, western blacknose dace (*Rhinichthys obtusus*), and white heelsplitter (*Lasmigona complanata*) are opportunistic generalists that prosper under degraded conditions. Although reductions in populations of these species are likely if habitat improvements occur, these declines should be viewed as restoration of community balance. Even though two species at risk in the Sydenham River (bigmouth buffalo and blackstripe topminnow) are tolerant of high turbidity, their populations will likely benefit from improvements in water quality.

As identified in the Overall Strategies/Approaches to Recovery section (under "Stewardship") above, work in riparian areas will be conducted in such a way that it does not interfere with the habitats and management of terrestrial species at risk. In most cases, riparian restoration will benefit terrestrial wildlife and plant species. There are also opportunities to combine efforts of this Recovery Strategy with terrestrial restoration efforts (e.g., tallgrass prairie and Northern Bobwhite (*Colinus virginianus*)). The OMNR has also initiated a project on rare trees of the Sydenham River watershed, which includes some suggestions for restoration that may integrate well with future riparian restoration projects.

Evaluation

Evaluation of the overall approaches to recovery set out in this Strategy will be largely accomplished through the routine monitoring program. RAGs will also endeavor to incorporate specific performance measures into individual RAPs. The routine monitoring program will assess the status of water quality, species at risk, and in-stream habitat through time. Where possible, target levels have been established for fish and mussel species in terms of abundance and occupied range. These targets will be used to assess progress. Although the Recovery Team had considerable discussions around water quality targets, it was determined that it was unlikely that realistic target values could be determined at the present time. During the 5-year period of the Strategy, the Recovery Team will work towards the development of water quality targets. The Recovery Strategy will be reviewed in 5 years to evaluate the progress on stated objectives and to identify additional approaches and changes that may be required.

II. SPECIES-SPECIFIC RECOVERY

A) MUSSELS

1. Recovery Goal:

I. The long-term goal specific to mussel species at risk is to maintain existing populations and restore ranges so that recovery habitat is reoccupied (through restoration of habitat and reintroductions if necessary).
II. Increase densities by one level using The Nature Conservancy's element occurrence rankings, where such rankings exist; for example, increase densities of the snuffbox from its current D-rank to C-rank (see Appendix 1). These specifications are species-specific and currently only available for the snuffbox and the northern riffleshell; however, rankings may become available for other species.

2. Short-Term Recovery Objectives:

I. Define current densities, distributions, and recruitment levels (population demographics) of all five mussel species.
II. Establish mussel monitoring index stations in the East Sydenham River (perhaps 5–10) to track population changes over time. Index stations should include the recovery habitat as well as the survival habitat so that range expansions can be detected.
III. Determine the fish hosts for each species as well as the distribution and population strength of these hosts.

3. Overall Strategies/Approaches to Recovery:

Priority	Objective No.	Broad Approach/ Strategy	Specific Steps	Anticipated Effect	Cost Estimates
Urgent	I, II, & III	Wavy-rayed lampmussel – surveys	Conduct targeted sampling for this species near Alvinston, where fresh shells have recently been found.	Will determine if species is still extant in the river; will allow establishment of index stations if species is present.	$3,000
Urgent	III	Wavy-rayed lampmussel – surveys for host fish	Conduct surveys for host fish (smallmouth bass); investigate the feasibility of reintroduction if necessary.	Determine the population status of the smallmouth bass.	$5,000
Urgent	I & III	Northern riffleshell – surveys	Conduct additional quadrat surveys throughout known range.	Will define population demographics.	$5,000
Necessary	–	Northern riffleshell – recovery planning	Contact U.S. authorities regarding their recovery efforts for this subspecies and investigate the possibility of an international recovery plan.	Coordinated international recovery efforts.	N/A
Urgent	I, II, & III	Snuffbox – surveys	Conduct additional surveys.	Fill gaps in its known range and define population demographics if possible (very low densities exist, and few live animals have been found).	$5,000
Necessary	III	Snuffbox – surveys for host fishes	Conduct surveys for logperch and blackside darters.	Determine current status of the suspected host fishes in the East Sydenham River.	$5,000

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Priority	Objective No.	Broad Approach/ Strategy	Specific Steps	Anticipated Effect	Cost Estimates
Urgent	III	Northern rifflesheil, rayed bean, and snuffbox – determination of host fishes	Extend existing research on host fish determination for these species.	Confirmation of host fish species.	$20,000
Urgent	I & II	Mudpuppy mussel – surveys	Conduct species-specific surveys for fresh shells.	Better define population.	$5,000
Necessary	III	Mudpuppy mussel – surveys for mudpuppy host	Conduct mudpuppy surveys.	Determine the health of the host population.	$5,000

B) FISHES

1. Recovery Goal:

The long-term goal specific to fish species at risk is to maintain existing populations and restore ranges so that recovery habitat is reoccupied (through restoration of habitat and reintroductions if necessary).

2. Short-Term Recovery Objectives:

I. Identify known habitats and species-specific habitat requirements.
II. Define distribution and abundance of fish species at risk.

3. Overall Strategies/Approaches to Recovery:

Priority	Objective No.	Broad Approach/ Strategy	Specific Steps	Anticipated Effect	Cost Estimates
Urgent	I & II	Eastern sand darter – monitoring	Identify suitable habitat patches in East Sydenham River and conduct targeted sampling to define range.	Will allow for complete delineation of range and identification of long-term monitoring sites.	$5,000
Urgent	I	Eastern sand darter – habitat protection	Map sources of sand upstream of occupied sites.	Will allow for protection of habitat.	part of above
Urgent	I	Northern madtom – monitoring	Identify habitat requirements through discussions with U.S. researchers. Determine if species is extant through targeted sampling in suitable habitat.	Will determine if species is still extant in the river.	$5,000
Necessary	VII	Northern madtom – reintroduction	If species is not found, develop a plan for reintroduction at Florence.	Will allow for reestablishment of species in Sydenham River.	TBD
Urgent	I	Spotted gar – monitoring	Identify suitable habitat patches in lower East Sydenham River and conduct targeted sampling. If species is not found, then no further recovery efforts should be directed towards the spotted gar in the Sydenham River.	Will determine if species is extant in Sydenham river so that future recovery actions can be identified.	$5,000

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Priority	Objective No.	Broad Approach/ Strategy	Specific Steps	Anticipated Effect	Cost Estimates
Necessary	I & II	Spotted sucker – monitoring	Identify habitat requirements through discussions with U.S. researchers. Targeted sampling is required during spring spawning period and summer. Movements should be determined through marking or radiotelemetry.	Will improve understanding of species and habitat use in the river.	TBD
Necessary	I & II	Pugnose minnow – monitoring	Identify suitable habitat patches in the North Sydenham and lower East Sydenham rivers and conduct targeted sampling to determine distribution.	Will allow for complete delineation of range and identification of long-term monitoring sites.	$5,000
Necessary	I & II	Blackstripe topminnow, greenside darter, bigmouth buffalo – monitoring	The range and abundance of these species should be monitored as part of routine surveys.	Will provide trend-through-time information on status of populations.	N/A

C) EASTERN SPINY SOFTSHELL

A draft Recovery Plan has been prepared for the eastern spiny softshell in Ontario (Oldham et al. 1997). Approaches identified here have been developed by adopting actions from the draft plan that are relevant to the Sydenham River.

1. Recovery Goal:

The long-term goal specific to the eastern spiny softshell is to maintain the existing population and occupied range in the Sydenham River.

2. Short-Term Recovery Objectives:

I. Prevent any net loss or fragmentation of habitat.
II. Refine current information on distribution and abundance, and identify and protect key habitat areas.
III. Coordinate actions with recovery efforts for other eastern spiny softshell populations.

3. Overall Strategies/Approaches to Recovery:

Priority	Objective No.	Broad Approach/ Strategy	Specific Steps	Anticipated Effect	Cost Estimates
Urgent	I, II, & III	Eastern spiny softshell – monitoring	Repeat population survey in East and North Sydenham rivers every 5 years in the spring and early summer.	Will determine the current range and abundance.	$5,000
Urgent	I, II, & III	Eastern spiny softshell – monitoring	Identify and describe nesting and overwintering habitats and factors that affect habitat quality.	Will allow for the identification and protection of key habitat areas.	$10,000

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Priority	Objective No.	Broad Approach/ Strategy	Specific Steps	Anticipated Effect	Cost Estimates
Beneficial	I	Eastern spiny softshell – habitat protection	Determine extent of nest predation, and erect nest enclosures if required.	Will increase recruitment.	TBD
Beneficial	I	Eastern spiny softshell – habitat protection	Reduce successional encroachment on nesting sites where succession is a problem.	Will maintain nesting habitat.	$1,000
Urgent	I	Eastern spiny softshell – habitat protection	Supply landowners of all nesting areas and other significant sites (basking areas, overwintering sites) with information on softshells and on activities that might be harmful.	Will encourage landowners to take an active role in conservation and information gathering.	$2,000
Beneficial	I & II	Eastern spiny softshell – awareness	Build on Eastern Spiny Softshell Recovery Team's efforts to raise awareness of softshells in the Sydenham River. For example, a web site is in development and will include information on the Sydenham River population.	Will increase support for stewardship activities and information gathering.	$5,000
Urgent	III	Eastern spiny softshell –coordination	Work cooperatively with the Eastern Spiny Softshell Recovery Team to ensure that priority actions and research needs are addressed.	Will coordinate efforts and pool resources of two Recovery Teams.	N/A

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Appendix 1.
Species-Specific Summaries

Wavy-raved Lampmussel (*Lampsilis fasciola*)

Species Information:

Scientific Name: *Lampsilis fasciola*

Common Name: Wavy-rayed lampmussel

Current COSEWIC Status & Year of Designation: Endangered (1999)

Range in Canada (provinces and territories where found): Ontario

Rationale for Status: The wavy-rayed lampmussel has declined significantly in recent years across its historical range. Its numbers have been reduced in Great Lakes waters by the zebra mussel, while populations in the Thames, Sydenham, and Ausable rivers are disappearing or have been lost, primarily as a result of agricultural impacts. This species exists in the Maitland River, but the status of the population has not yet been determined.

Distribution:

Global Range: In the United States, the wavy-rayed lampmussel currently occurs in Indiana, Illinois, Kentucky, Michigan, New York, Virginia, Pennsylvania, and North Carolina. It historically occurred in Alabama, West Virginia, Tennessee, and Georgia, but the status of the species in these states is currently unknown. In Canada, the wavy-rayed lampmussel occurs only in southern Ontario.

Canadian Range: The current Canadian distribution of the wavy-rayed lampmussel is restricted to the upper Grand River and limited sections of the Ausable, Thames, and possibly the Sydenham rivers. Recently, its presence has been confirmed in the Maitland River.

Percentage of Global Distribution in Canada: Less than 5% of the species' global distribution is currently found in Canada.

Nationally Significant Populations: The upper Grand River population, covering a 60-km reach, is the healthiest known population remaining in Canada and is therefore nationally significant.

Population Sizes and Trends: The wavy-rayed lampmussel is an uncommon species throughout its range, but globally secure (G4). Comparisons of historical and recent data show that the species has declined in numbers and/or range in most jurisdictions where it historically occurred. The wavy-rayed lampmussel has presumably been lost from western Lake Erie, Lake St. Clair, and the Detroit River due to zebra mussels. Its distribution in the Grand River has contracted and is now restricted to 60 km of the upper river, with densities of up to eight animals captured per 4.5 person-hours of search effort. In the Thames and Sydenham rivers, it appears that the wavy-rayed lampmussel has always been rare, with very few historical records existing. Based on live animals and fresh shells, this species may still survive in an 8-km reach of the upper Thames River near Dorchester and a 5-km reach of the upper East Sydenham River near Alvinston (fresh shells only). Its presence in the Ausable River is uncertain, and recent surveys revealed fresh shells only. A single survey site on the Maitland River revealed the presence of live animals, but further surveys are required to determine the extent of the population.

Biologically Limiting Factors: The wavy-rayed lampmussel is a long-term brooder with two known fish hosts, the smallmouth bass (*Micropterus dolomieu*) and largemouth bass (*M. salmoides*), although specific hosts in Canada remain unknown. Displaying females attract the host fish with a minnow-shaped "lure," and reproductive success may be somewhat dependent on water clarity. The glochidia are known to be very sensitive to copper, and copper concentrations often exceed federal aquatic life guidelines in both the Grand and Thames rivers.

Threats: The wavy-rayed lampmussel is vulnerable to impoundments, loss of host fish, siltation, and toxic chemicals, as well as zebra mussels and muskrats (*Ondatra zibethicus*) in portions of its range. Recreational canoeing has also been noted as a potential impact in the Grand River, where canoe traffic can cause excessive substrate disturbances. Zebra mussels do not currently threaten riverine populations in Canada; however, the Grand River population would be at risk if zebra mussels became established in one or more of three large reservoirs in the upper watershed. In the Grand River, sedimentation and pollution from urban and agricultural runoff are major threats to water and habitat quality for the wavy-rayed lampmussel. The rapid rate of human population growth projected for the watershed is expected to put further pressure on water quality. There are also concerns that increased fishing pressure in the Grand River could reduce smallmouth bass populations to levels that could affect the wavy-rayed lampmussel. The apparent disappearance of this species from the Ausable and Sydenham rivers may be attributed to poor water quality due to high turbidity levels caused by intensive agriculture. It has been speculated that the wavy-rayed lampmussel may have a critical requirement for clear water during reproduction, as the female must rely on good visibility in order to attract a sight predator, such as a smallmouth bass, with her lure. Further investigation is required in the Maitland River to determine the population status of the wavy-rayed lampmussel in this river and what potential threats may exist, although water clarity was noted to be good.

Habitat Requirements:

Recovery Habitat: The wavy-rayed lampmussel inhabits clear, hydrologically stable rivers and streams of a variety of sizes, where it is typically found in gravel or sand substrates in and around riffle areas. Recovery habitat could include the 60 km of the upper Grand River, an unknown section of the Maitland River (to be determined by future surveys), and the historically occupied reaches of the Ausable, Sydenham, and Thames rivers.

Survival Habitat: The portion of the recovery habitat needed to prevent extinction of the species cannot be identified at present. However, we could define the survival habitat as the gravel or sand substrates in and around riffle areas where live animals or fresh shells currently exist. This would include such sections of the 60-km stretch of the upper Grand River, 5 km of the upper East Sydenham near Alvinston, 8 km of the upper Thames River, and an undetermined reach of the Maitland River.

Habitat Trends: Former habitat in the Great Lakes and connecting channels is now infested with zebra mussels. Agricultural impacts in particular have resulted in the degradation of habitat for the wavy-rayed lampmussel in the Sydenham, Ausable, and Thames rivers with high levels of turbidity. In the Grand and Maitland rivers, turbidity is less of a problem; however, water quality issues related to agriculture and urban populations are evident. Habitat trends, including water quality, have not been investigated on the Maitland River.

Habitat Protection/Ownership: The federal Fisheries Act may represent the most important legislation protecting the habitat of the wavy-rayed lampmussel in Canada, as fish are broadly defined under the Act to include shellfish. Stream-side development in Ontario is managed through floodplain regulations enforced by local conservation authorities. Land throughout all five watersheds where the wavy-rayed lampmussel occurs is mainly privately owned and in agricultural use.

Ecological Role: Mussels are filter feeders, feeding on algae, bacteria, and organic matter in the water column. They serve as natural biological filters and food for fish and wildlife.

Socioeconomic Considerations: The species is of no economic significance.

Recovery Potential and Rationale:

Ecological and Technical Feasibility of Species Recovery:[3]
(i) Mussels are slow-growing and sedentary and dependent on the movements of their host fishes for dispersal of their young. This slow rate of population growth makes recovery of decimated populations extremely difficult.
(ii) Habitat in the Sydenham River appears to be of low quality due to high turbidity and possible loss of the host fish.
(iii) and (iv) It is believed that habitat in the East Sydenham River could be improved significantly with good stewardship of agricultural lands; however, reducing levels of turbidity and restoring populations of the smallmouth bass will be challenging.
(v) Captive breeding of the wavy-rayed lampmussel has not yet been attempted. Identification of the smallmouth and largemouth bass as host fish in Canada needs to be confirmed as well.

The level of effort required for recovery in the East Sydenham River would be high, possibly requiring long-term population augmentation of the mussel itself and possibly also the host fish.

Anticipated Conflicts or Challenges: Tile drainage represents a unique challenge to the improvement of water quality in the East Sydenham River, since impacts are difficult to mitigate. The large size of the watershed means that recovery will be a long-term prospect requiring substantial funds and support by the farming community.

Knowledge Gaps:

Survey Requirements: Further surveys are required to confirm the presence/absence of remnant populations of the wavy-rayed lampmussel in the East Sydenham near Alvinston. Additional surveys are needed, particularly on the Maitland River, where populations have not been characterized. Additional investigation into the Maitland River watershed is required to determine dominant threats.

Biological/Ecological Research Requirements: Research is required to confirm the fish host for the wavy-rayed lampmussel in Canada. It is also necessary to investigate further the apparent disappearance of the smallmouth bass in the Sydenham River.

Threat Clarification Research Requirements: Further research is required to determine the possible link between high turbidities and reproductive failure that has been hypothesized.

[3] In each species-specific summary, this section addresses the following: (i) the species' inherent capacity to rebound demographically, (ii) the current availability of quality habitat, (iii) the possibility of restoring habitat, if required, (iv) the capability of alleviating threat factors, and (v) the capacity for captive breeding/reintroduction, if required.

Rayed Bean (*Villosa fabalis*)

Species Information:

Scientific Name: *Villosa fabalis*

Common Name: Rayed bean

Current COSEWIC Status & Year of Designation: Endangered (1999)

Range in Canada (provinces and territories where found): Ontario

Rationale for Status: The rayed bean was once widely distributed throughout its original range in North America, but has declined significantly in distribution and abundance in recent years. In Canada, it now occurs only in a 45-km stretch of the East Sydenham River, where it is threatened by siltation and pollution associated with intensifying agricultural activities.

Distribution:

Global Range: In the United States, the rayed bean currently occurs in Alabama, Indiana, Kentucky, Michigan, New York, Ohio, Pennsylvania, Tennessee, and West Virginia. In Canada, it occurs only in southern Ontario.

Canadian Range: The current Canadian distribution of the rayed bean is limited to a 45-km stretch of the East Sydenham River.

Percentage of Global Distribution in Canada: Less than 10% of the species' global distribution is currently found in Canada.

Nationally Significant Populations: The East Sydenham River population of the rayed bean is believed to be the only remaining population in Canada and is therefore nationally significant.

Population Sizes and Trends: The rayed bean is presumed extirpated from Illinois and Virginia as well as from the Detroit River, the Thames River, and western Lake Erie in Ontario. There is a general consensus that the species has significantly declined in distribution and abundance in recent years, although population trends are difficult to quantify due to the paucity of numerical data (many studies note only presence or absence). In Canada, the rayed bean appears to be restricted to a 45-km reach of the East Sydenham River, where it occurs at low densities. The current range of the rayed bean in the Sydenham River has changed little over time. Recent sampling that involved intensive searches of its preferred habitat indicates that it may be more abundant than previously thought, and a broad range of sizes of living specimens captured shows that the population is successfully reproducing (Woolnough and Mackie 2001). "Element occurrence specifications" developed by The Nature Conservancy may soon be available for rating the strength of the Sydenham River population (federal listing of this species is expected in the United States).

Biologically Limiting Factors: The rayed bean is a long-term brooder with only one known fish host. The fish host in Canada is currently unknown, since the species of darter identified as the host in the United States does not occur here. Like other species of mussels, dependency on the fish host can make the species very sensitive to changes in the fish community. Due to its burrowing habits, the rayed bean may be more directly exposed to sediment-associated contaminants than most other mussel species.

Threats: The rayed bean is vulnerable to impoundments, siltation, and pollution, as well as zebra mussels and loss of its fish hosts. Agricultural chemicals and siltation are likely the most significant threats to the continued existence of this species in North America. Due to its burrowing habits, the rayed bean is less likely than other species to be threatened by zebra mussels. Nonetheless, former populations in zebra mussel-infested waters (Detroit River and western Lake Erie) have disappeared. There is some evidence that species of this genus may be very sensitive to environmental contaminants. The remaining populations in Canada found in the East Sydenham River are threatened by intensive agricultural activity and exposed to fertilizers and pesticides, in addition to siltation (all facilitated by extensive tile drainage). The added stress of point source pollution from urban centres and manure and physical destruction due to livestock farming may have extirpated the species from the Thames River.

Habitat Requirements:

Recovery Habitat: The rayed bean tends to inhabit the headwaters and smaller tributaries of river systems, where it is found in or near riffle areas. The rayed bean is usually found deeply buried in the substrate, among the roots of aquatic vegetation. Live specimens encountered in the Sydenham River were found buried in stable substrates of sand or fine gravel, generally in low-flow areas along the margins of the river or the edges of small islands. The currently occupied habitat in the East Sydenham River consists of a 45-km stretch from Croton to Alvinston. Including sites with the presence of fresh shells above and below this stretch, the range of the rayed bean expands to about 65 km, which should be considered recovery habitat.

Survival Habitat: The portion of the recovery habitat needed to prevent extinction of the species cannot be identified at present. We could assume that the survival habitat is the 45-km stretch of the East Sydenham where the rayed bean is currently found live. We have no data on rayed bean occurrence in suboptimal habitats and therefore cannot determine the significance of these habitats to population viability.

Habitat Trends: Former habitat in the Great Lakes and connecting channels is now infested with zebra mussels. Agricultural impacts have likely resulted in the degradation of habitat for the rayed bean in both the Thames and Sydenham rivers.

Habitat Protection/Ownership: The federal Fisheries Act may represent the most important legislation protecting the habitat of the rayed bean in Canada, as fish are broadly defined under the Act to include shellfish. Stream-side development in Ontario is managed through floodplain regulations enforced by local conservation authorities. Land along the reach of the Sydenham River where the rayed bean occurs is mainly privately owned and in agricultural use.

Ecological Role: Mussels are filter feeders, feeding on algae, bacteria, and organic matter in the water column. They serve as natural biological filters and food for fish and wildlife.

Socioeconomic Considerations: The species is of no economic significance.

Recovery Potential and Rationale:

Ecological and Technical Feasibility of Species Recovery:
(i) Mussels are slow-growing and sedentary and dependent on the movements of their host fishes for dispersal of their young. This slow rate of population growth makes recovery of decimated populations extremely difficult.
(ii) Habitat quality in the East Sydenham has not been defined and may be good to marginal based on the limited data available. Signs of recruitment are encouraging, but heavy loads of suspended solids are likely compromising habitat quality.
(iii) and (iv) It is believed that habitat in the East Sydenham River could be improved significantly with good stewardship of agricultural lands. Restoration of zebra mussel-infested waters is not feasible. Habitat in the Thames River may be unrecoverable, due to the degraded condition of the upper Thames where the species

once occurred.
(v) Captive breeding of the rayed bean has not yet been attempted. Identification of the host fish in Canada would need to be confirmed as well.

The level of effort required for recovery would be moderate in the East Sydenham River (e.g., habitat restoration) and high in the Thames River (e.g., translocation, long-term population augmentation).

Anticipated Conflicts or Challenges: Tile drainage represents a unique challenge to the improvement of water quality in the East Sydenham River, since impacts are difficult to mitigate. The large size of the watershed means that recovery will be a long-term prospect requiring substantial funds and support by the farming community.

Knowledge Gaps:

Survey Requirements: Very little is known about the strength of the population in the Sydenham River, and additional surveys are required to determine true densities and levels of recruitment. Due to the small size and deep burrowing habits of the rayed bean, specific surveys for this species require careful excavation of the substrate and sifting for live animals. Long-term index survey sites should be established in the East Sydenham River in order to track population responses to watershed recovery.

Biological/Ecological Research Requirements: The most critical aspect of ecological requirements for the rayed bean is the identification of the primary fish host in Canada. Once this has been determined, the distribution and abundance of the host fish should be determined within the Sydenham River to ensure that host availability is not limiting the rayed bean's distribution.

Threat Clarification Research Requirements: As per Snuffbox. It is extremely unlikely that the main presumed threats to its continued existence (i.e., agricultural chemicals and siltation) are not the cause of declines.

Northern Riffleshell (*Epioblasma torulosa rangiana*)

Species Information:

Scientific Name: *Epioblasma torulosa rangiana*

Common Name: Northern riffleshell

Current COSEWIC Status & Year of Designation: Endangered (1999)

Range in Canada (provinces and territories where found): Ontario

Rationale for Status: The northern riffleshell has suffered a range reduction of more than 95% over the past century. In Canada, it occurs only in the Ausable and Sydenham rivers, with the later population one of only three known reproducing populations in North America.

Distribution:

Global Range: In the United States, the northern riffleshell currently occurs in the Green River, Kentucky; French Creek, Leboeuf Creek, and the Allegheny River in Pennsylvania; Detroit River in Michigan; Big Darby Creek in Ohio; the Oak River and Elk River in West Virginia; and Fish Creek in Indiana and Ohio. In Canada, the northern riffleshell occurs only in southern Ontario.

Canadian Range: The current Canadian distribution of the northern riffleshell is limited mainly to a 50-km stretch of the Sydenham River. A remnant population was recently discovered in the Ausable River in southern Ontario, based on the presence of two individuals (Staton et al. 2000a). Although populations in Great Lakes waters are presumed extirpated due to zebra mussels, a single live individual was found in a wetland area of Lake St. Clair in 2000 (D. Zanatta, Environment Canada, personal commununication).

Percentage of Global Distribution in Canada: Approximately 25% of the northern riffleshell's global distribution and population abundance is currently found in the Sydenham River (remnant populations in Lake St. Clair and the Ausable River would be considered to contribute negligibly to the global distribution).

Nationally Significant: The Sydenham River is both nationally and globally significant. It is home to one of only three populations in North America (and the only population in Canada) that still shows evidence of successful reproduction.

Population Sizes and Trends: The northern riffleshell has suffered dramatic declines in North America over the past century, with the current distribution representing a range reduction of greater than 95%. The Allegheny River and French Creek in Pennsylvania support the largest remaining populations in the United States. In Canada, it appears that the current distribution in the East Sydenham River is essentially the same as the historical distribution; however, there is evidence to suggest that abundance has declined by as much as 90% over the past 30 years. Current densities in the Sydenham River range from 2 to 11 animals captured per 4.5 person-hours of search effort. Using The Nature Conservancy's "element occurrence specifications," the Sydenham River population qualifies as a B-ranked occurrence. It generally falls into the C-ranked occurrence category for density (low to moderate density; 1–2 live animals per 2–3 survey hours), but was assigned a B-rank based on the extensive length of river occupied. Recent surveys in the Ausable River showed evidence that historical northern riffleshell populations may once have been larger than the Sydenham River population; however, this population has suffered severe declines, and few live animals now exist.

Biologically Limiting Factors: The northern riffleshell is a long-term brooder with few fish hosts. The fish host(s) in Canada are currently unknown; none of the species of darters and sculpins identified as hosts in the United States occur here. The glochidia are morphologically depressed, and thus the species is predisposed to low rates of recruitment. Dependency on the fish host also makes the northern riffleshell susceptible to changes in the fish community. The main factor limiting the occurrence of the northern riffleshell throughout its range is believed to be the availability of silt-free riffle habitat.

Threats: The northern riffleshell has narrow habitat requirements and is extremely vulnerable to impoundments, siltation, and pollution, as well as zebra mussels and loss of its fish hosts. All rivers in Canada and the United States where the northern riffleshell is found are located in areas of intense agriculture and forestry and are susceptible to siltation and runoff of agricultural chemicals. The main threats to the Sydenham River population are agriculture-related and include runoff of silt, fertilizers, and pesticides from cropland (facilitated by extensive tile drainage), reduced riparian vegetation, and habitat destruction by cattle access to the stream. Zebra mussels have decimated populations in Lake St. Clair, the Detroit River, and the shoals of western Lake Erie, but the Sydenham River remains a refuge from these invaders. There is some evidence that muskrat predation could be a contributing threat in the Sydenham River.

Habitat Requirements:

Recovery Habitat: The northern riffleshell lives mainly in highly oxygenated riffle areas of rivers and streams of various sizes with firmly packed sand and gravel substrates. It also inhabited shoals in western Lake Erie and Lake St. Clair, where wave action was sufficient to produce continuously moving water. The historically occupied habitat in the Sydenham River consists of a 55-km stretch of the East Sydenham from Dawn Mills to a distance of 5 km upstream of Alvinston. Live animals were found recently at sites throughout this reach except for the uppermost 5 km above Alvinston, where fresh shells only were found.

Survival Habitat: The portion of the recovery habitat needed to prevent extinction of the species cannot be identified at present. We could assume that the survival habitat is the 50-km stretch of the East Sydenham where the northern riffleshell is currently found live. We have no data of northern riffleshell occurrence in non-riffle areas and therefore cannot determine the significance of these areas to population viability.

Habitat Trends: Former habitat in the Great Lakes and connecting channels has been lost due to the zebra mussel, although isolated patches may still occur in a few wetland areas sheltered from zebra mussel veligers. Agricultural impacts have likely resulted in the degradation of habitat for the northern riffleshell in both the Ausable and Sydenham rivers.

Habitat Protection/Ownership: The federal Fisheries Act may represent the most important legislation protecting the habitat of the northern riffleshell in Canada, as fish are broadly defined under the Act to include shellfish. Stream-side development in Ontario is managed through floodplain regulations enforced by local conservation authorities. Land along the reach of the Sydenham and Ausable rivers where the northern riffleshell occurs is mainly privately owned and in agricultural use.

Ecological Role: Mussels are filter feeders, feeding on algae, bacteria, and organic matter in the water column. They serve as natural biological filters and food for fish and wildlife.

Socioeconomic Considerations: The species is of no economic significance.

Recovery Potential and Rationale:

Ecological and Technical Feasibility of Species Recovery:
(i) Mussels are slow-growing and sedentary and dependent on the movements of their host fishes for dispersal of their young. The northern riffleshell is generally rare to begin with and has low levels of recruitment due to

glochidial morphology; therefore, it would be particularly slow to rebound demographically.
(ii) Habitat quality in the East Sydenham has not been defined and may be good to marginal based on the limited data available. Signs of recruitment are encouraging, but heavy loads of suspended solids are likely compromising habitat quality. Habitat quality in the Ausable River appears to be marginal at best, with poor water quality, extensive impacts from intensive livestock farming, and evidence of extensive population declines in recent years.
(iii) and (iv) It is believed that habitat in the East Sydenham River could be improved significantly with good stewardship of agricultural lands. Restoration of habitat in the Ausable River would be more challenging due to the intensity of numerous impacts, including intensive livestock operations. Restoration of zebra mussel-infested waters is not feasible.
(v) Captive breeding of *Epioblasma* species has only recently been attempted (in Virginia), and its success has not yet been demonstrated. Identification of the host fish in Canada would need to be confirmed as well.

The level of effort required for recovery would be moderate in the East Sydenham River (e.g., habitat restoration) and high in the Ausable River (e.g., translocation, long-term population augmentation).

Anticipated Conflicts or Challenges: Tile drainage represents a unique challenge to the improvement of water quality in the East Sydenham River, since impacts are difficult to mitigate. The large size of the watershed means that recovery will be a long-term prospect requiring substantial funds and support by the farming community.

Knowledge Gaps:

Survey Requirements: Wetland areas in Lake St. Clair and western Lake Erie should be surveyed to determine if there are any significant refuge sites remaining in Great Lakes waters. If wetland refuges exist for this species, further research could be conducted to enhance these populations. Further surveys in the Ausable River are required to determine the status of the existing population (evidence of recruitment and extent of population). Further surveys in the Sydenham are required to determine northern riffleshell presence in suboptimal habitats (i.e., deeper, non-riffle habitats). This would give a much better estimate of the population, since riffles constitute only a small fraction of the available habitat in the zone where the northern riffleshell currently exists. Staton et al. (2000b) quantified habitat types. Long-term index survey sites should be established in the East Sydenham River in order to track changes in population density and distribution.

Biological/Ecological Research Requirements: The most critical aspect of ecological requirements for the northern riffleshell is the identification of the primary fish host in Canada. Without this information, recovery efforts could be made in vain.

Threat Clarification Research Requirements: As per Snuffbox.

Snuffbox (*Epioblasma triquetra*)

Species Information:

Scientific Name: *Epioblasma triquetra*

Common Name: Snuffbox

Current COSEWIC Status & Year of Designation: Endangered (2001)

Range in Canada (provinces and territories where found): Ontario

Rationale for Status: The snuffbox has been lost from 60% of its former range in North America. Remaining populations are small and fragmented, and most are in decline. In Canada, it is now restricted to perhaps 200 animals in a 50-km reach of the East Sydenham River. This population represents one of only about 50 extant occurrences in North America.

Distribution:

Global Range: The snuffbox currently occurs in Alabama, Arkansas, Illinois, Indiana, Kentucky, Michigan, Minnesota, Mississippi, Missouri, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia, Wisconsin, and Ontario.

Canadian Range: The snuffbox currently occurs only in the East Sydenham River in Ontario.

Percentage of Global Distribution in Canada: Less than 5% of the species' global distribution is currently found in Canada. Population abundance estimates are not available.

Nationally Significant Populations: The Sydenham River population of the snuffbox is believed to be the only remaining population in Canada and is therefore nationally significant.

Population Sizes and Trends: No abundance estimates are available for the global population. It is extirpated from Iowa and Kansas and probably New York. It is also believed to be extirpated from Lake Erie, Lake St. Clair, the Niagara River, and the Grand, Thames, and Ausable rivers in Ontario. The rate of change in geographical distribution is not available, but it has been lost from 60% of formerly occupied streams. In order to rank the quality of snuffbox populations, The Nature Conservancy has developed "element (species) occurrence specifications" based on capture rates and reproductive potential as well as habitat suitability and size. An A-ranked occurrence is defined (in part) by a capture rate of 2–3+ live animals per survey hour, while B-, C-, and D-ranked occurrences are defined as 1 live animal per hour, 1 live animal per 2–4 hours, and 1–2 live animals per 1–2 days, respectively. The Sydenham River population would qualify for a D-ranked occurrence based on current capture rates at the four sites where it was found alive in 1997–1999.

Biologically Limiting Factors: The snuffbox is a long-term brooder with few fish hosts. Both traits make it particularly vulnerable to the population-level impacts of the zebra mussel. Only two of its five known fish hosts (blackside darter, *Percina maculata*, and logperch, *P. caprodes*) occur in Ontario, and the logperch may be declining in the Sydenham River. Research is required to confirm/disprove whether these two fish species are functional hosts for the snuffbox in the Sydenham River watershed. The snuffbox has morphologically depressed glochidia, which predisposes it to a low rate of recruitment. It is believed to be extremely sensitive to siltation because of its specialized habitat requirements and burrowing habits.

Threats: The snuffbox is sensitive to pollution, siltation, habitat perturbation, inundation, loss of glochidial hosts, and zebra mussels. Sites where it still occurs are high-quality streams with little disturbance to the substrate or riparian zone. The impoundment of large rivers has destroyed much of the habitat for the snuffbox in the United States, although dams do not threaten Canadian populations. Seventy percent of historical records for the snuffbox in Canada are from areas now infested with zebra mussels. Main threats to the Sydenham River population are agriculture-related, i.e., runoff of silt, fertilizers, and pesticides from cropland via extensive tile drainage, reduced stream shading due to a lack of riparian vegetation, and habitat destruction/inputs of manure from cattle having access to the river.

Habitat Requirements:

Recovery Habitat: The habitat requirements of the snuffbox are highly specialized. It is typically found in small- to medium-sized rivers in shallow riffle areas with clean, clear, swift-flowing water and firm rubble/gravel/sand substrates that are free of silt. It was also found in wave-washed shoals in the Great Lakes. The historically occupied habitat in the Sydenham River consists of a 30-km reach of the East Sydenham River between Shetland and Dawn Mills. Small numbers of live animals were recently found in this reach and 20 km farther upstream near Alvinston; in addition, a fresh shell was found in 2001 much farther upstream at a site just downstream of the dam in Strathroy. Recovery habitat would therefore constitute the majority of the main stem of the East Sydenham River from Dawn Mills to Coldstream.

Survival Habitat: Specific characteristics of the habitat required to prevent the extinction of the species (e.g., the tolerance limit for siltation) are not known. Research is needed to identify the microhabitat requirements of both adults and juveniles. Survival habitat cannot be identified at present, since no more than two specimens were found alive at any given site.

Habitat Trends: Former habitat in the Great Lakes and connecting channels has likely been lost due to the zebra mussel, with the possible exception of a few wetland areas with very specific features. Agricultural impacts have likely resulted in a loss of habitat for the snuffbox in the Grand, Thames, Sydenham, and Ausable rivers.

Habitat Protection/Ownership: The federal Fisheries Act may represent the most important legislation protecting the habitat of the snuffbox in Canada, as fish are broadly defined under the Act to include shellfish. Stream-side development in Ontario is managed through floodplain regulations enforced by local conservation authorities. Land along the reach of the Sydenham River where the snuffbox occurs is privately owned and in agricultural use.

Ecological Role: Mussels are filter-feeders, feeding on algae, bacteria, and organic matter in the water column. They serve as natural biological filters and food for fish and wildlife.

Socioeconomic Considerations: The species is of no economic significance.

Recovery Potential and Rationale:

Ecological and Technical Feasibility of Species Recovery:
(i) Mussels are slow-growing and sedentary and must rely on the movements of their host fishes for the dispersal of their young. This slow rate of population growth makes recovery of decimated mussel populations extremely difficult.
(ii) The only known habitat for this species is in the East Sydenham River. Whether this habitat is of good or marginal quality is not known.
(iii) and (iv) It is believed that habitat in the Sydenham River could be recovered or improved significantly with good stewardship of cropland. Habitat in the Thames and Ausable rivers may be unrecoverable due to the intensity of livestock farming in the basin. Habitat in zebra mussel-infested waters is also unrecoverable.

(v) Captive breeding of *Epioblasma* species has only recently been attempted (in Virginia), and its success has not yet been demonstrated. Genetic issues must be resolved before translocations from populations in the United States could be considered.

The level of effort required for recovery is likely moderate (reduce inputs of silt and agricultural chemicals to the river).

Anticipated Conflicts or Challenges: As per other mussels.

Knowledge Gaps:

Survey Requirements: Wetland areas in Lake St. Clair and Lake Erie should be surveyed to determine if there are any significant refuge sites left in the Great Lakes. Characteristics of these sites should then be studied so that the habitat needs of this and other rare and endangered species of freshwater mussels can be considered in the design of wetland restoration projects. Further surveys should be conducted in the Ausable River to determine if it supports a reproducing population or a remnant population (scattered, old, non-reproductive individuals). Additional surveys to determine the demographics of the Sydenham River population must also be conducted.

Biological/Ecological Research Requirements: Life history studies must be conducted to determine its age and size at sexual maturity, recruitment success, age class structure, environmental requirements, and viable population size. Specific effects of various perturbations (e.g., siltation, agricultural chemicals, domestic and industrial effluents, fluctuations in temperature, dissolved oxygen, pH, and flow) and the levels at which they are limiting must be determined. The most critical aspect requiring research is the identification of the functional fish host, i.e., the species that is the primary host for the snuffbox in Canada.

Threat Clarification Research Requirements: Factors presumed to be causing the decline of this and other freshwater mussels have, for the most part, not been tested empirically. However, observational studies have provided compelling evidence of probable cause/effect relationships in most cases. Since few threats occur in isolation, it may be difficult or impossible to consider them separately. It is extremely unlikely that the main presumed threats, i.e., agricultural activities and zebra mussels, are not the cause of the decline of this species.

Mudpuppy Mussel (*Simpsonaias ambigua*)

Species Information:

Scientific Name: *Simpsonaias ambigua*

Common Name: Mudpuppy mussel

Current COSEWIC Status & Year of Designation: Endangered (2001)

Range in Canada (provinces and territories where found): Ontario

Rationale for Status: The mudpuppy mussel has been lost from 60% of its former range in North America, and some remaining populations are in decline. In Canada, it was historically known from the Detroit and Sydenham rivers; it is now believed to be restricted to a 50-km reach of the East Sydenham River. Its continued existence in Canada may depend on the status of its amphibian host, the mudpuppy (*Necturus maculosus*), which could be threatened by increasing sediment loads from agricultural lands.

Distribution:

Global Range: The mudpuppy mussel currently occurs in Arkansas, Illinois, Indiana, Kentucky, Minnesota, Missouri, Ohio, Pennsylvania, West Virginia, Wisconsin, and Ontario.

Canadian Range: The mudpuppy mussel currently occurs only in the East Sydenham River in Ontario.

Percentage of Global Distribution in Canada: Less than 5% of the species' global distribution is currently found in Canada. Population abundance estimates are not available.

Nationally Significant Populations: The Sydenham River population of the mudpuppy mussel is believed to be the only remaining population in Canada and is therefore nationally significant.

Population Sizes and Trends: There are no estimates of population size for this species from any location in any jurisdiction, including Ontario; however, it is no longer found in 60% of formerly occupied rivers and streams in the United States and is extirpated from Iowa, New York, Tennessee, and Michigan. In Canada, it was historically known from the Detroit and Sydenham rivers, but recent surveys in both rivers show that it now occurs only in the Sydenham River. Seventeen live animals, 42 fresh shells/valves, and 30 weathered shells/valves were collected from eight different sites within a 50-km reach of the East Sydenham River in 1997–1999. The broad range of sizes for live specimens and fresh shells indicated that there is ongoing recruitment. The Nature Conservancy noted that the mudpuppy mussel may not be found by the usual mussel collection methods and that most populations are located by the presence of fresh shells.

Biologically Limiting Factors: The mudpuppy mussel is the only species of freshwater mussel that uses an amphibian host, the mudpuppy. Although the mudpuppy is designated "Not At Risk" in Canada, it is known to be very sensitive to siltation and environmental contamination. The mudpuppy mussel is small, is a long-term brooder, and has only one host; mussel species with these traits are particularly susceptible to the zebra mussel.

Threats: The mudpuppy mussel is a very poorly known species of freshwater mussel, and threats to its existence are not well understood. Zebra mussels are impacting the mudpuppy mussel in the Kentucky River and may be responsible for the loss of this species from the Detroit River. Zebra mussels are not found in the Sydenham River

but would be a definite threat if they became established in an upstream reservoir. The most significant threat to the Sydenham River population of the mudpuppy mussel is probably the indirect effects of siltation on its host. The status of the mudpuppy in this river is not known and should be investigated.

Habitat Requirements:

Recovery Habitat: The mudpuppy mussel is most commonly found in sand or silt under large, flat stones in areas of swift current, which is consistent with the habitat of its host. The recovery habitat in the Sydenham River is not known, since there are only two historical records. Live animals and fresh shells have recently been found at four sites in a 50-km reach of the East Sydenham River that includes the historical sites; thus, this reach constitutes the minimum recovery habitat. Single records for shells in the upper Thames River and upper Bear Creek suggest that these areas could also be considered part of the recovery habitat.

Survival Habitat: The survival habitat is considered to be the 17-km reach of the Sydenham River between Shetland and just downstream of Croton, where live animals were recently found and there was evidence of recent recruitment. Characteristics of this habitat that allow it to sustain populations of the mudpuppy mussel are unknown.

Habitat Trends: Former habitat in the Detroit River has been lost due to the zebra mussel. Agricultural impacts may have resulted in a loss of habitat for the mudpuppy mussel in the Sydenham River.

Habitat Protection/Ownership: The federal Fisheries Act may represent the most important legislation protecting the habitat of the mudpuppy mussel in Canada, as fish are broadly defined under the Act to include shellfish. Stream-side development in Ontario is managed through floodplain regulations enforced by local conservation authorities. Land along the reach of the Sydenham River where the mudpuppy mussel occurs is privately owned and in agricultural use.

Ecological Role: Mussels are filter-feeders, feeding on algae, bacteria, and organic matter in the water column. They serve as natural biological filters and food for fish and wildlife. There is some evidence that the mudpuppy may prey on the mudpuppy mussel.

Socioeconomic Considerations: The species is of no economic significance.

Recovery Potential and Rationale:

Ecological and Technical Feasibility of Species Recovery:
(i) Mussels are slow-growing and sedentary and must rely on the movements of their hosts for the dispersal of their young. This slow rate of population growth makes recovery of decimated mussel populations extremely difficult. According to The Nature Conservancy, however, the broad distribution of the mudpuppy mussel in streams, smaller rivers, and lakes suggests that its potential for recovery may be greater than that of many other rare freshwater mussels.
(ii) The only known habitat for this species is in the East Sydenham River. Whether this habitat is of good or marginal quality is not known.
(iii) and (iv) It is believed that habitat in the Sydenham River could be recovered or improved significantly with good stewardship of cropland. Habitat that may be occupied by the host, i.e., flat rocks, submerged logs, wooden slabs, and other debris that mudpuppies use for shelter and nesting, should not be disturbed or destroyed. Habitat in the zebra mussel-infested waters of the Detroit River is unrecoverable.
(v) Captive breeding has not been attempted for this poorly known species.

The level of effort required for recovery is likely moderate (reduce inputs of silt and agricultural chemicals to the river).

Anticipated Conflicts or Challenges: As per other mussel species.

Knowledge Gaps:

Survey Requirements: Additional surveys should be conducted in the Sydenham River to more precisely determine the extent of occurrence and relative abundance of this species. This baseline information is needed to more specifically identify critical habitat and track recovery. Surveys to determine the status of its host in the Sydenham River are also needed.

Biological/Ecological Research Requirements: In order to effectively manage the mudpuppy mussel, much more must be known about its biology and environmental requirements.

Threat Clarification Research Requirements: The primary threat to this species is presumed to be indirect, i.e., the effects of siltation on its host, but this factor requires further investigation. If action is taken to improve conditions for the host, when in fact the host is not at risk, these actions are likely to be ineffective.

Eastern Sand Darter (*Ammocrypta pellucida*)

Species Information:

Scientific Name: *Ammocrypta pellucida*

Common Name: Eastern sand darter

Current COSEWIC Status & Year of Designation: Threatened (1994)

Range in Canada (provinces and territories where found): Restricted to southern Ontario and southern Quebec

Rationale for Status: Loss of habitat and deteriorating water quality have resulted in population declines and reduced distribution in Canada.

Distribution:

Global Range: The eastern sand darter occurs in the Ohio River, Lake Erie, and Lake St. Clair drainages as well as the Ausable River flowing into the southern tip of Lake Huron. It also has a disjunct distribution in the Lake Champlain and St. Lawrence River drainages. It is known from nine states and from the provinces of Ontario and Quebec.

Canadian Range: In Canada, the eastern sand darter is restricted to southwestern Ontario and southwestern Quebec. In Ontario, the species is extant in Lake St. Clair, Lake Erie, the Grand River, the Thames River and the Sydenham River. Populations may be extirpated from the Ausable River, Catfish Creek, Big Creek, and Big Otter Creek. In Quebec, the eastern sand darter has been collected from 10 tributaries of the St. Lawrence as well as from the St. Lawrence River, Lac des Deux-Montagnes, and Lac St. Pierre. It is thought to be extant in the Rivière Gentilly, extirpated or reduced in four rivers (Châteaugay, Yamaska, l'Assomption, St. François), and the status is unknown at the other locations. In the Sydenham River, the eastern sand darter is known only from the east branch. It was first collected at Strathroy in 1927 and was collected at Alvinston in 1929. The species was collected near Florence in 1972, and its continued presence in this vicinity has been confirmed through repeated collections over the last 13 years. The eastern sand darter was also collected downstream in the vicinity of Croton in the early 1990s.

Percentage of Global Distribution in Canada: About 5% of the species' global range occurs in Canada.

Nationally Significant Populations: None has been identified.

Population Sizes and Trends: The eastern sand darter is globally rare (G3) and has declined throughout much of its North American range due to siltation and deteriorating water quality (Page and Burr 1991; Holm and Mandrak 1994). In some parts of its range, these declines have been somewhat drastic. The eastern sand darter is listed as endangered in three states (Illinois, New York, Pennsylvania), threatened in two states (Michigan, Vermont), and of special concern in three states (Indiana, Kentucky, Ohio). The species was listed as threatened in Canada by COSEWIC in 1994 (Holm and Mandrak 1994). The eastern sand darter has probably disappeared from half of the Canadian watersheds that it was known from historically, and its abundance and range have been reduced in many others. There is no good information on the abundance of the eastern sand darter in the East Sydenham River, but its range appears to have decreased. Eight collection attempts in 1991 in apparently suitable habitats between Strathroy and Alvinston failed to capture any eastern sand darters (Holm and Mandrak 1994). The species is still extant in the vicinity of Florence. Since there are no historical data downstream of Alvinston, it is not clear whether the overall range of the eastern sand darter has contracted or if it has simply shifted downstream (Holm and Mandrak 1994).

Biologically Limiting Factors: The eastern sand darter has a strong affinity for clean substrates of fine sand. Eastern sand darters are fossorial and will often nearly completely bury themselves in sandy substrates. Eggs are likely laid and buried in the same substrates. A well-oxygenated clean sand substrate is likely required for high egg survival and to allow for fossorial behaviour. The fecundity of the eastern sand darters is low (30–170 mature eggs per female), but is comparable to that of other darter species.

Threats: The availability of silt-free, soft sand substrates is likely the most important limiting factor for eastern sand darters in the Sydenham River. Loadings of suspended solids from a variety of sources (Jacques Whitford Environment Ltd. 2001), leading to siltation of fine sand substrates, is probably the largest threat to eastern sand darter populations. Creation of the impoundment at Strathroy in the 1960s may have had a negative impact on eastern sand darters in the upper portion of the East Sydenham River. The impact of high nutrient levels and toxic chemicals is unknown, but is not expected to be positive. If the round goby (*Neogobius melanostomus*) becomes established in the lower portion of the East Sydenham River, it may pose a significant risk to the remaining population of eastern sand darters.

Habitat Requirements:

Recovery Habitat: The eastern sand darter inhabits large creeks, rivers, and lakes with sandy bottoms (Page and Burr 1991). The species is found almost exclusively on sand substrates, and, according to Daniels (1993), few temperate stream fishes are as strongly associated with a particular habitat variable as is the eastern sand darter. In rivers, these habitats tend to be patchy and are normally found on the depositional side of a bend in the river. Eastern sand darters are normally found on the downstream end of the sandbar in areas of low current (<20 cm/s) (Daniels 1993; Facey 1998). These sandy habitats are somewhat ephemeral, in that they can be created or destroyed or moved by flood events and ice action. In the Sydenham River, the species has been collected from areas with silted sand bottoms (Holm and Mandrak 1994). However, land use practices that contribute to siltation and that change the channel structure and interfere with the deposition of sand are probably detrimental to the eastern sand darter and have probably been largely responsible for the range-wide declines reported for this species. There is no information available to assess whether the preference of this species for sand is constant throughout its life history, although spawning does occur on the same sandy substrates on which it lives. In the Sydenham River, recovery habitat should be considered to be patches of fine sand substrate in the east branch of the river.

Survival Habitat: Survival habitat should be considered to be patches of fine sand substrate in the 15-km stretch of river between Florence and Dawn Mills.

Habitat Trends: Although the quality of eastern sand darter habitat has not been quantified, the high turbidity and nutrient levels in the Sydenham River have likely resulted in degradation of habitat. Some of the remaining eastern sand darter habitat in the Sydenham River has been subject to siltation (Holm and Mandrak 1994), but there are also relatively silt-free patches remaining.

Habitat Protection/Ownership: The habitat of the eastern sand darter receives general protection under the habitat provisions of the federal Fisheries Act. Floodplain regulations enforced by the St. Clair Region Conservation Authority and the Provincial Policy Statement under the provincial Planning Act provide some control over stream-side development. The bed of the Sydenham River is owned by the Crown, but the majority of adjacent lands on the portion of the river inhabited by the eastern sand darter are privately owned and in agricultural use.

Ecological Role: The eastern sand darter feeds on small insects (primarily midges and blackflies), crustaceans, and worms. The low abundance of the eastern sand darter suggests that it does not play an important role in food web dynamics; however, at the microhabitat level, it is one of the few Ontario fishes that exploits sand habitats and their resources. It is possible that the eastern sand darter may be a glochidial host for one of the endangered mussel species in the Sydenham River.

Socioeconomic Considerations: The eastern sand darter is currently a legal baitfish in Ontario, but it is unlikely that it is harvested. Given its rarity and small numbers, the eastern sand darter is of little economic significance.

Recovery Potential and Rationale:

Ecological and Technical Feasibility of Species Recovery:
(i) The eastern sand darter has the ability to recover when habitat improvements are made. There is evidence from Vermont that improvements in water quality associated with a decreased silt load resulting from reforestation of stream slopes have benefited populations of eastern sand darters (Daniels 1993).
(ii) The current availability of quality habitat is probably low, although apparently suitable habitats in the upper portion of the East Sydenham River are not currently occupied. Habitat assessment is required to determine the suitability of these sites.
(iii) and (iv) Restoration of habitat requires reductions in sediment input from a variety of sources (overland erosion, drainage tiles, bank, and bed). This will require a large basin-wide effort to be effective. The natural erosion of sand banks is important to maintaining habitat for this species.
(v) It may be possible to reintroduce this species to formerly occupied upstream areas if the habitat is suitable; however, given the rarity of this species in the Sydenham River and other systems, it would be very difficult to find a source population.

The level of effort required for recovery of the Sydenham population would be moderate (habitat restoration and protection).

Anticipated Conflicts or Challenges: Efforts to reduce erosion in the watershed must recognize that natural erosion of sand banks is important to the maintenance of habitat for this species. Other challenges are as for other species.

Knowledge Gaps:

Survey Requirements: The current extent of the eastern sand darter in the Sydenham River needs to be confirmed. This should be accomplished by first identifying locations of suitable sandy habitat patches in the East Sydenham River and then sampling the best sites by seining. Ongoing indexed monitoring is required to assess changes in abundance at occupied sites.

Biological/Ecological Research Requirements: Sampling should be conducted to determine if sandy habitat patches are used by all life stages and to determine if these patches are used throughout the year.

Threat Clarification Research Requirements: An assessment of the quality of habitat patches versus the abundance of eastern sand darters would be useful in quantifying the impacts of siltation on this species.

Spotted Gar (*Lepisosteus oculatus*)

Species Information:

Scientific Name: *Lepisosteus oculatus*

Common Name: Spotted gar

Current COSEWIC/OMNR Status & Year of Designation: Threatened (2000, uplisted from Special Concern (1983, 1994)); Ontario – Threatened (2000)

Range in Canada (provinces and territories where found): Restricted to southern Ontario

Rationale for Status: More than one-half of Canadian populations have been lost, and the species remains at only a few locations.

Distribution:

Global Range: The spotted gar is widely distributed in the Gulf states, the Mississippi River basin, and the southern Great Lakes drainages. It is known from 18 states and the province of Ontario.

Canadian Range: In Ontario, the spotted gar has been collected from Lake Erie (five locations), Lake St. Clair, the Sydenham River, and the Bay of Quinte (presumed introduction). It is now thought to be extant only in Lake Erie (Rondeau and perhaps Long Point), although specific sampling targeting this species has not been conducted. In the Sydenham River, the spotted gar is known only from two individuals identified in the lower east branch in 1975. One fish was released, and the identification of both specimens has been questioned (Campbell 1994a). Recently, the 36-mm larval specimen captured farther upstream was reidentified as a longnose gar (*Lepisosteus osseus*) with "reasonable confidence" (E. Holm, Royal Ontario Museum, personal communication). However, the other specimen was captured in a gill net and thus would have been larger, and the identification would have been more certain (E. Holm, Royal Ontario Museum, personal communication). The spotted gar is an enigmatic creature that is rarely observed even in areas where there are established populations, such as Rondeau Bay. Only 18 specimens have ever been recorded from Ontario waters. This is undoubtedly due to its rarity coupled with the difficulties in sampling its preferred wetland habitats. The species may also be incorrectly identified as the more common longnose gar and released by sampling crews. It is not clear whether the specimens collected from the Sydenham River in 1975 represented an established population or single nomadic individuals that had originated from Lake St. Clair or Lake Erie. Both specimens were captured during the summer months after the spring spawning period.

Percentage of Global Distribution in Canada: Less than 1% of the species' global range occurs in Canada.

Nationally Significant Populations: None has been identified. The largest Canadian population probably occurs in Rondeau Bay of Lake Erie.

Population Sizes and Trends: The spotted gar is globally secure (G5) but is extremely rare throughout the northern portion of its range. It is not clear if this rarity is the result of declines or if the spotted gar has always been rare in the north. The spotted gar is listed as endangered in Ohio. The species has not been seen in the Sydenham River since its initial collection in 1975, and it is not clear if the species is extant or if it was ever present in the Sydenham River. Additional sampling is required using appropriate techniques to determine if the spotted gar is present in the Sydenham River.

Biologically Limiting Factors: The spotted gar prefers wetland habitats. The availability of quiet backwater areas of dense aquatic vegetation is a limiting factor.

Threats: The spotted gar prefers quiet backwater areas of dense aquatic vegetation. Siltation, drainage, and filling have probably all contributed to the reduction of these types of habitats in the Sydenham River. Wetlands in the Sydenham drainage basin accounted for 30% of the area pre-settlement, but are now less than 1% of the total area (Nelson 2001). Competition with the closely related and more abundant longnose gar represents a possible, but unquantified, threat to the spotted gar.

Habitat Requirements:

Recovery Habitat: The spotted gar inhabits quiet pools, backwaters, and bays with an abundance of aquatic vegetation (Page and Burr 1991). Collection sites in Lake Erie typically had dense vegetative cover consisting of *Nuphar* sp., *Typha* sp., and *Elodea canadensis* (Parker and McKee 1984a). The spotted gar spawns in the spring in shallow, warm water with an abundance of submerged vegetation (Scott and Crossman 1973). Some populations may migrate upstream to spawn. Semi-adhesive eggs are laid over aquatic vegetation, submerged brush, and debris. Recovery habitat could be considered as quiet vegetated areas of the lower East Sydenham sub-watershed.

Survival Habitat: Survival habitat cannot be quantified at this time. Sampling is required to determine if the species is currently present in the lower East Sydenham River.

Habitat Trends: The quantity and quality of spotted gar habitat in the lower East Sydenham River have not been assessed. Although there has been a long-term, watershed-wide loss of wetland habitats, there is no information available on recent trends in vegetated/wetland areas in the river.

Habitat Protection/Ownership: The habitat of the spotted gar receives general protection under the habitat provisions of the federal Fisheries Act. Floodplain regulations enforced by the St. Clair Region Conservation Authority and the Provincial Policy Statement under the provincial Planning Act provide some control over stream-side development. The bed of the Sydenham River is owned by the Crown, but the majority of adjacent lands on the portion of the river inhabited by the spotted gar are privately owned and in agricultural use.

Ecological Role: The spotted gar is a voracious piscivore that probably will opportunistically feed on all fish species of suitable size that it encounters. Although data are very limited, Scott (1967) listed yellow perch (*Perca flavescens*) and minnows (*Cyprinidae*) as forming a large part of the diet in Ontario. Young spotted gar initially feed on invertebrates, but incorporate small fish into their diet at an early age.

Socioeconomic Considerations: The spotted gar does not have economic value, but has been maligned as a predator of more valued species. Given its rarity and small numbers, the spotted gar is of little economic significance.

Recovery Potential and Rationale:

Ecological and Technical Feasibility of Species Recovery:
(i) The inherent capacity for this species to rebound demographically is unknown.
(ii) The current availability of quality wetland habitat in the Sydenham River is low.
(iii) and (iv) If the spotted gar is still extant in the Sydenham River, improvements in water quality and reductions in sediment loading from good land use practices will benefit the vegetated/wetland habitats preferred by this species.
(v) Specific recovery efforts directed at this species should take place only if it is verified to be extant in the system, as it cannot be said with certainty that the spotted gar was present in the system historically. Therefore, repatriation will not be part of the recovery approaches for this species at this time.

The level of effort required for recovery of the Sydenham population would be moderate (habitat restoration and protection).

Anticipated Conflicts or Challenges: Challenges are as for other species.

Knowledge Gaps:

Survey Requirements: Targeted sampling is required in the lower East Sydenham River to determine if this species is extant. Patches of suitable habitat in this stretch of the river should be identified prior to sampling. The most effective means of sampling include boat electrofishing and hoop nets in areas of suitable habitat.

Biological/Ecological Research Requirements: If a population of spotted gars is present in the Sydenham, diet and seasonal habitat use should be investigated, and spawning areas should be identified.

Threat Clarification Research Requirements: Long-term monitoring is required to assess the cumulative impacts of upstream habitat improvements on spotted gar habitat. The impact of competition with longnose gar should be investigated.

Northern Madtom (*Noturus stigmosus*)

Species Information:

Scientific Name: *Noturus stigmosus*

Common Name: Northern madtom

Current COSEWIC/OMNR Status & Year of Designation: Special Concern (1998); Ontario – Threatened (2000)

Range in Canada (provinces and territories where found): Restricted to extreme southwestern Ontario

Rationale for Status: This is a globally rare species that is declining and extremely rare in Canada.

Distribution:

Global Range: The northern madtom occurs sporadically in the Mississippi River, Ohio River, western Lake Erie, and Lake St. Clair drainages. It is known from nine states and the province of Ontario.

Canadian Range: In Ontario, the species is known only from the upper Detroit River, Lake St. Clair, the Thames River, and the Sydenham River. The northern madtom is known from the East Sydenham River from only one specimen collected in 1975 near Florence. The specimen was in the Canadian Museum of Nature collection and had been misidentified as *Noturus miurus* (brindled madtom). The species has not been seen in the Sydenham River since, despite fish sampling in the vicinity of Florence.

Percentage of Global Distribution in Canada: Approximately 5% of the species' global range occurs in Canada.

Nationally Significant Populations: None has been identified. The largest Canadian populations occur in the upper Detroit River and southern Lake St. Clair.

Population Sizes and Trends: The northern madtom is globally rare (G3), and declines have been noted in Illinois, Michigan, and Ohio. It is most common, although still rare, in the southern part of its range (Mississippi, Tennessee). The northern madtom is listed as endangered in three states (Illinois, Michigan, Ohio), threatened in one state (Pennsylvania), and of special concern in one state (Kentucky). The northern madtom may be extirpated from the Sydenham River. The species has not been seen in the Sydenham River since its initial collection in 1975, despite fish sampling in the vicinity of Florence in 1989, 1991, 1997, 1999, and 2001. However, the northern madtom is a small, secretive, nocturnal species that is difficult to capture using traditional sampling techniques. Seining at night in suitable habitats is probably the most effective means of searching for northern madtoms in the Sydenham River. An unsuccessful attempt was made to capture the northern madtom by night seining at the initial capture location in 1999. Additional sampling is required using appropriate techniques to determine if the northern madtom is still extant in the Sydenham River.

Biologically Limiting Factors: The northern madtom is a cavity spawner. Nests are made underneath large rocks as well as in a variety of anthropogenic debris (Holm and Mandrak 1998). Availability of suitable nesting sites may be a limiting factor. The northern madtom has a low fecundity, but the nest-guarding behaviour of males enhances the survival of eggs and young.

Threats: Threats for the northern madtom in the Sydenham River are poorly understood. Evidence suggests that it tolerates a wide variety of habitat conditions, although it may be affected by poor water quality. Siltation could affect this species' ability to nest in cavities. Temperature is undoubtedly an important limiting factor, as the Sydenham record is among the most northerly for this species. If the round goby (*Neogobius melanostomus*) invades the upper portions of the East Sydenham River, it could potentially impact any remaining populations of the northern madtom. However, the nest-guarding behaviour of male northern madtoms (which do not abandon nests when disturbed) (MacInnis 1998) and their nocturnal activity pattern may allow this species to co-exist with introduced gobies. It is unknown whether the other madtoms present in similar habitats in the Sydenham River (brindled madtom, and stonecat, *Noturus flavus*) have an impact on the northern madtom.

Habitat Requirements:

Recovery Habitat: The northern madtom inhabits clear to turbid stretches of large creeks to big rivers with moderate to swift current and a variety of substrate types (Holm and Mandrak 1998). It has also been collected from sandy substrates without cover and is occasionally associated with aquatic macrophytes (Holm and Mandrak 1998). Given the extremely restricted distribution of the northern madtom, there may be very specific, but undescribed, habitat characteristics. In the Sydenham River, the species was collected in an area with numerous riffles. Recovery habitat could be considered to be riffle areas in the stretch of river between Shetland and Dawn Mills.

Survival Habitat: Survival habitat (if indeed the species is still extant) should be considered to be riffle areas in the vicinity of Florence on the East Sydenham River.

Habitat Trends: Although the quality of northern madtom habitat has not been quantified, the high turbidity and nutrient levels in the Sydenham River may have resulted in degradation of habitat.

Habitat Protection/Ownership: The habitat of the northern madtom receives general protection under the habitat provisions of the federal Fisheries Act. Floodplain regulations enforced by the St. Clair Region Conservation Authority and the Provincial Policy Statement under the provincial Planning Act provide some control over stream-side development. The bed of the Sydenham River is owned by the Crown, but the majority of adjacent lands on the portion of the river inhabited by the northern madtom are privately owned and in agricultural use.

Ecological Role: The northern madtom appears to be an opportunistic feeder. Gut contents of Ontario specimens have typically contained a variety of benthic insects (chironomids, mayflies, and caddisflies), but small fish and small crustaceans are also consumed (Holm and Mandrak 1998). The few juveniles that have been examined also fed on benthic insects. Most feeding probably occurs nocturnally.

Socioeconomic Considerations: Given its rarity and small numbers, the northern madtom is of little economic significance.

Recovery Potential and Rationale:

Ecological and Technical Feasibility of Species Recovery:
(i) The inherent capacity for this little known species to rebound demographically is unknown.
(ii) The habitat for this species is poorly understood, but may be limiting
(iii) and (iv) If the northern madtom is still extant in the Sydenham River, improvements in water quality and reductions in sediment loading from stewardship programs will benefit this species.
(v) If it is extirpated, then significant intervention would be required to reintroduce the northern madtom to the river. The only viable source population would be in the upper Detroit River. A more complete understanding of the habitat requirements of this species is required to determine why it may have disappeared from the Sydenham River.

The level of effort required for recovery of the Sydenham population would be moderate to high (habitat restoration and protection and perhaps repatriation).

Anticipated Conflicts or Challenges: Challenges are as for other species.

Knowledge Gaps:

Survey Requirements: Targeted sampling is required in the vicinity of Florence to determine if this species is extant in the Sydenham River. Night seining is the sampling technique that should be used.

Biological/Ecological Research Requirements: A better understanding of the habitat requirements of this species and its ecological relationship with congeners is required to assess the current situation in the Sydenham River. This would be best accomplished through collaboration with U.S. researchers.

Threat Clarification Research Requirements: Impacts of siltation and competition with other madtoms should be investigated.

Spotted Sucker (*Minytrema melanops*)

Species Information:

Scientific Name: *Minytrema melanops*

Common Name: Spotted sucker

Current COSEWIC/OMNR Status & Year of Designation: Special Concern (1983, updated in 1994); Ontario – Vulnerable (2000)

Range in Canada (provinces and territories where found): Restricted to extreme southwestern Ontario

Rationale for Status: This is a rare species with a limited range in southwestern Ontario that is sensitive to changes in water quality.

Distribution:

Global Range: The spotted sucker occurs in smaller drainages in the southern Great Lakes, throughout much of the Mississippi basin, and along the lower coastal plain from Texas to North Carolina. It is known from 23 states and from the province of Ontario.

Canadian Range: In Ontario, the spotted sucker is known from the Sydenham River (both branches), the St. Clair River, Lake St. Clair, the Thames River, the Detroit River, and Lake Erie (west of Point Pelee). Recent collections have confirmed that the species is extant at all of these locations except Lake Erie. The spotted sucker was first collected from the Sydenham drainage in 1975 at two sites in the East Sydenham River. It was subsequently collected in the north branch in Black Creek in 1982 and in Bear Creek in 1997. The continued presence of the spotted sucker in the East Sydenham River was confirmed in 1997. Very few individuals have been captured in the Sydenham River, as all collections represent single individual fish (similar to other Canadian collections). Parker and McKee (1984b) suggested that the Sydenham and Thames rivers may provide spawning areas for a small resident population of spotted suckers in Lake St. Clair. The possibility cannot be discounted that this species is a year-round resident of the Sydenham River.

Percentage of Global Distribution in Canada: Less than 5% of the species' global range occurs in Canada.

Nationally Significant Populations: None has been identified. In Canada, nine of 29 specimens have been collected from the Sydenham River, while other records are from nearby Chenail Ecarte, St. Clair River, and Lake St. Clair.

Population Sizes and Trends: The spotted sucker is globally secure (G5), but declines have been reported in the northern part of its range (Becker 1983). It is listed as a species of special concern in Pennsylvania and Kansas. The spotted sucker has been collected only sporadically in the Sydenham River, and little can be said regarding population trends. The species has been captured recently in both the East and North Sydenham rivers.

Biologically Limiting Factors: The spotted sucker is apparently intolerant of turbidity (Trautman 1957; Scott and Crossman 1973), but it has been taken from rivers with moderate to heavy turbidity (including the Sydenham River).

Threats: Erosion and associated turbidity are probably the greatest threat to this species in the Sydenham River. It is also likely that temperature is important in limiting this species, which is at the northern edge of its range in the Sydenham River.

Habitat Requirements:

Recovery Habitat: The spotted sucker generally inhabits long, deep pools of small to medium-sized rivers over clay, sand, or gravel substrates and is occasionally found in small creeks and impoundments (Page and Burr 1991). It has also been reported from water bodies with dense aquatic macrophytes and organic substrates, but is generally considered to prefer firm substrates (Cross 1967). The spotted sucker spawns in late spring or early summer over clean riffle areas where semi-buoyant eggs are laid that drift downstream (Parker and McKee 1984b). In the Sydenham watershed, recovery habitat could be considered as deep pool and riffle areas in the lower East Sydenham River, Black Creek, and Bear Creek. In addition, recovery habitat could include the closely associated St. Clair and Detroit rivers as well as Lake St. Clair, where several individuals have been captured (E. Holm, Royal Ontario Museum, personal communication).

Survival Habitat: Survival habitat is difficult to quantify at this time. Until further sampling has been conducted, survival habitat should be considered to be deep pool and riffle areas within 5 km of recent capture locations in the East Sydenham River and Bear Creek.

Habitat Trends: Although the quality of spotted sucker habitat has not been quantified, the high turbidity in the Sydenham River may have resulted in degradation of habitat.

Habitat Protection/Ownership: The habitat of the spotted sucker receives general protection under the habitat provisions of the federal Fisheries Act. Floodplain regulations enforced by the St. Clair Region Conservation Authority and the Provincial Policy Statement under the provincial Planning Act provide some control over stream-side development. The bed of the Sydenham River is owned by the Crown, but the majority of adjacent lands on the portion of the river inhabited by the spotted sucker are privately owned and in agricultural use.

Ecological Role: Juvenile and adult spotted suckers feed on a variety of benthic organisms. Molluscs, chironomids (midges), and small crustaceans are important in the diet. Larval spotted suckers feed at the surface and at mid-water on zooplankton and diatoms.

Socioeconomic Considerations: The spotted sucker may occasionally be taken by anglers or by commercial fishermen in mixed-species coarse fisheries. Given its rarity and small numbers, the spotted sucker is of little economic significance.

Recovery Potential and Rationale:

Ecological and Technical Feasibility of Species Recovery:
(i) and (ii) The ability of this species to rebound demographically as well as the availability of quality habitat are currently unknown.
(iii) and (iv) Efforts to reduce erosion and sedimentation on a watershed scale will benefit the spotted sucker in the Sydenham River by reducing turbidity in the system.
(v) As the species is still extant in the system and in connecting waters (St. Clair River), it is unlikely that reintroductions need to be considered.

The level of effort required for recovery of the Sydenham population would be moderate (habitat restoration and protection).

Anticipated Conflicts or Challenges: Challenges are as for other species.

Knowledge Gaps:

Survey Requirements: In addition to monitoring spotted suckers as part of standard surveys, efforts should be made to sample deep pools in the vicinity of historic capture sites during the summer months.

Biological/Ecological Research Requirements: Seasonal habitat use should be investigated, and spawning areas should be identified. All captured fish should be marked so that movements within the watershed can be determined.

Threat Clarification Research Requirements: Long-term monitoring is required to assess the cumulative impacts of upstream habitat improvements on spotted sucker populations.

Pugnose Minnow (*Opsopoeodus emiliae*)

Species Information:

Scientific Name: *Opsopoeodus emiliae*

Common Name: Pugnose minnow

Current COSEWIC/OMNR Status & Year of Designation: Special Concern (1985, updated in 2000); Ontario – Vulnerable (2000)

Range in Canada (provinces and territories where found): Restricted to extreme southwestern Ontario

Rationale for Status: This is a rare species with a limited range in southwestern Ontario that is sensitive to changes in water quality.

Distribution:

Global Range: The pugnose minnow is widely distributed in the Gulf states and the Mississippi River basin and is found in a few drainages of Lake Erie, Lake St. Clair, and Lake Michigan. It is known from 21 states and the province of Ontario.

Canadian Range: In Ontario, the pugnose minnow occurs in Lake St. Clair and several small tributaries of the lake, the Sydenham River (both branches), the Thames River, and the Detroit River. The pugnose minnow was first collected from the North Sydenham River in 1972. Subsequent collections revealed that it occurred in the lower North Sydenham River, upstream into Bear Creek. The pugnose minnow was first found in the lower East Sydenham River in 1979.

Percentage of Global Distribution in Canada: Less than 5% of the species' global range occurs in Canada.

Nationally Significant Populations: None has been identified. The Sydenham River represents a significant portion of the pugnose minnow's Canadian range.

Population Sizes and Trends: The pugnose minnow is globally secure (G5) but is rare and may be declining in the northern part of its range (Cudmore and Holm 1999). It is listed as extirpated from Ohio, threatened in Georgia, and of special concern in Missouri and West Virginia. In the Sydenham River, large numbers of individuals have never been encountered, and the species has not been collected recently in the North Sydenham River or in Bear Creek, despite sampling efforts in 1993, 1996 (hindered by high water), and 1997. It may have disappeared from this section of the river. In 1997, sampling efforts revealed that the pugnose minnow is still extant in the lower East Sydenham River, although little can be said regarding population trends.

Biologically Limiting Factors: The pugnose minnow lays eggs on the underside of flat surfaces such as rocks, which may be limiting in the vegetated habitats it prefers. Male pugnose minnows have an elaborate courtship display, which may require clear water to be effective (Cudmore and Holm 1999).

Threats: Erosion and associated turbidity negatively affect the densely vegetated habitats that this species prefers. Filling and drainage of riparian wetland habitats would also further limit this species in the Sydenham drainage. Cudmore and Holm (1999) suggest that turbid water may affect the elaborate courtship display of the male pugnose minnow.

Habitat Requirements:

Recovery Habitat: The pugnose minnow prefers clear, slow-moving waters with abundant aquatic vegetation. Although specific tolerances are not known, turbid and silty waters may provide only marginal habitat for this species (Cudmore and Holm 1999). In Ontario, the pugnose minnow has been captured at sites with a variety of water clarities, but all sites had moderate to abundant aquatic vegetation. Recovery habitat could be considered slow-moving vegetated areas in the lower East Sydenham River, the North Sydenham River, and the lower end of Bear Creek.

Survival Habitat: Survival habitat should be considered to be slow-moving vegetated areas in the stretch of river between Wallaceburg and Dawn Mills, as well as tributaries such as Molly's Creek, where the species is still extant.

Habitat Trends: The quantity and quality of pugnose minnow habitat in the Sydenham River have not been assessed. Although there has been a long-term, watershed-wide loss of wetland habitats, there is no information available on recent trends in vegetated/wetland areas in the river.

Habitat Protection/Ownership: The habitat of the pugnose minnow receives general protection under the habitat provisions of the federal Fisheries Act. Floodplain regulations enforced by the St. Clair Region Conservation Authority and the Provincial Policy Statement under the provincial Planning Act provide some control over stream-side development. The bed of the Sydenham River is owned by the Crown, but the majority of adjacent lands on the portion of the river inhabited by the pugnose minnow are privately owned and in agricultural use.

Ecological Role: The pugnose minnow feeds on a variety of small insects and crustaceans and occasionally on larval fish and fish eggs. The upturned mouth of this species may be an adaptation to mid-water or surface feeding habits (Scott and Crossman 1973).

Socioeconomic Considerations: The pugnose minnow is a legal baitfish in Ontario; however, due to its small size and rarity, it is of little economic significance.

Recovery Potential and Rationale:

Ecological and Technical Feasibility of Species Recovery:
(i) The inherent capacity of this small cyprinid species is unknown.
(ii) The availability of quality habitat is currently unknown and needs to be assessed. It is suspected that the high turbidity in the system may be limiting habitat.
(iii) and (iv) Efforts to reduce erosion and sedimentation on a watershed scale will benefit the pugnose minnow in the Sydenham River by reducing turbidity in the system. This should enhance the vegetated habitats it prefers.
(v) As the species is still extant in the system, it is unlikely that reintroductions need to be considered.

The level of effort required for recovery of the Sydenham population would be moderate (habitat restoration and protection).

Anticipated Conflicts or Challenges: Challenges are as for other species.

Knowledge Gaps:

Survey Requirements: In addition to monitoring pugnose minnows as part of standard surveys, efforts should be made to determine if the species is still extant in the North Sydenham River/Bear Creek. This should be preceded by identification and assessment of suitable vegetated habitats, which should be sampled with seine nets. Similar habitat assessments should be conducted on the lower East Sydenham River.

Biological/Ecological Research Requirements: The relationship of habitat quality (patch size, stem density, and plant species composition) to occurrence and density of pugnose minnows should be investigated.

Threat Clarification Research Requirements: Long-term monitoring is required to assess the cumulative impacts of upstream habitat improvements on pugnose minnow populations and their habitats.

Blackstripe Topminnow (*Fundulus notatus*)

Species Information:

Scientific Name: *Fundulus notatus*

Common Name: Blackstripe topminnow

Current COSEWIC/OMNR Status & Year of Designation: Special Concern (1985, retained May 2001) (Mandrak and Holm 2000); Ontario – Vulnerable (2000)

Range in Canada (provinces and territories where found): Ontario

Rationale for Status: The blackstripe topminnow has a highly restricted distribution with low numbers, occurring only within the Sydenham River watershed in Canada. Its habitat is somewhat threatened and consists of in-stream and stream-side vegetation for specialized surface-insect feeding.

Distribution:

Global Range: The blackstripe topminnow occurs in lowland areas of the southern Great Lakes, throughout much of the Mississippi basin, and along the lower coastal plain from Texas to Alabama. It is known from 16 states and from southern Ontario.

Canadian Range: The current Canadian distribution is limited to the Sydenham River watershed. Here it occurs in the North Sydenham River basin (including Bear, Black, Fox, Booth, East Otter, Crooked, Molly's, and Ryan's creeks) as well as the lower East Sydenham River.

Percentage of Global Distribution in Canada: Less than 5% of the species' global distribution is currently found in Canada.

Nationally Significant Populations: The Sydenham River population is the only known population in Canada and is therefore nationally significant.

Population Sizes and Trends: No population estimates have been made of the blackstripe topminnow in Canada or in the United States. In the Sydenham River, there is no evidence of any population declines, although the earliest historical records are from 1972. Visual observations of up to 50 individuals near the surface have been recorded in the North Sydenham River.

Biologically Limiting Factors: Population sizes of the blackstripe topminnow are limited by the amount of stream-side vegetation, aquatic vegetation, and stream-side terrestrial insect fauna.

Threats: The blackstripe topminnow is threatened by habitat destruction, including the removal of riparian vegetation and disturbances reducing emergent and floating aquatic macrophytes. Channelization and wetland drainage are detrimental to the species. Damage to riparian vegetation by livestock access has been noted in the Sydenham watershed. Seepage from oil wells in Black Creek has also been identified as a threat for this surface-feeding species.

Habitat Requirements:

Recovery Habitat: The blackstripe topminnow prefers small to large, low-gradient streams and sloughs of moderate to high turbidity and is apparently tolerant of a wide range in water quality. Stream-side and aquatic vegetation are important, and the species relates closely to this cover. It also occurs in pools of intermittent streams. Recovery habitat could be defined as the entire North Sydenham River sub-watershed as well as the lower East Sydenham downstream of Tupperville.

Survival Habitat: The portion of the recovery habitat needed to prevent extinction of the species has not been identified at present. However, survival habitat should include all areas within its current recovery habitat that have intact riparian and aquatic vegetation and existing populations. More detailed habitat surveys and sampling throughout the recovery habitat could determine this. Examples of activities likely to result in destruction of survival habitat include channelization and removal of riparian vegetation.

Habitat Trends: The trends in quality and quantity of critical habitat are unknown, although it is noted that edge cover has been destroyed by livestock in some areas. Undoubtedly, historical channelization and wetland drainage have reduced available habitat throughout its range in the Sydenham River watershed.

Habitat Protection/Ownership: The habitat of the blackstripe topminnow receives general protection under the habitat provisions of the federal Fisheries Act. Floodplain regulations enforced by the St. Clair Region Conservation Authority and the Provincial Policy Statement under the provincial Planning Act provide some control over stream-side development. The bed of the Sydenham River is owned by the Crown, but the majority of adjacent lands on the portion of the river inhabited by the blackstripe topminnow are privately owned and in agricultural use.

Ecological Role: Blackstripe topminnows play an important role in the ecosystem in terms of the exclusivity with which they feed on terrestrial insects in summer (McAllister 1987). Few other Canadian fish species feed on terrestrial insects to this extent. This species may be an important prey fish where it is abundant.

Socioeconomic Considerations: The species is of no economic significance.

Recovery Potential and Rationale:

Ecological and Technical Feasibility of Species Recovery: Since the Sydenham population has shown no evidence of decline, maintaining current populations rather than "recovering" them is more relevant here.
(i) The species' inherent capacity to rebound demographically is unknown.
(ii) The availability of quality habitat has not been quantified but has likely been reduced somewhat by livestock destruction of edge cover. This species appears to thrive in turbid water and therefore may not be affected by sedimentation.
(iii) and (iv) Degraded sections of riparian habitat could be replanted, and cattle could be fenced from creeks.
(v) The capacity for captive breeding of the blackstripe topminnow is unknown.

The level of effort required for recovery (maintenance) of the Sydenham population would be low (mainly limited to habitat preservation of existing occupied habitats), with some limited habitat restoration, as mentioned above.

Anticipated Conflicts or Challenges: Restoration efforts that result in turbidity reductions are unlikely to negatively impact blackstripe topminnow populations.

Knowledge Gaps:

Survey Requirements: The range and abundance of the blackstripe topminnow in the Sydenham River should be monitored as part of the routine monitoring program.

Biological/Ecological Research Requirements: The extent of riparian zones throughout its range in the Sydenham needs to be quantified.

Threat Clarification Research Requirements: Research could be done to confirm/disprove the effects of oil seepage on populations in the north branch of the Sydenham River.

Greenside Darter (*Etheostoma blennioides*)

Species Information:

Scientific Name: *Etheostoma blennioides*

Common Name: Greenside darter

Current COSEWIC/OMNR Status & Year of Designation: Special Concern (1990); Ontario – Not in Any Risk Category (2000)

Range in Canada (provinces and territories where found): Restricted to southwestern Ontario

Rationale for Status: This is a rare species with a limited range in southwestern Ontario that is sensitive to changes in water quality.

Distribution:

Global Range: The greenside darter occurs in southern Great Lakes drainages (Huron, St. Clair, Erie, and Ontario), throughout much of the Mississippi basin (there is a hiatus in its range in southern Illinois and Indiana), and along the Atlantic slope from New York to Virginia. It is known from 17 states and from the province of Ontario.

Canadian Range: In Canada, the greenside darter is known from several drainages in southwestern Ontario: Ausable River, Sydenham River, Thames River, Lake St. Clair, Big Creek, and Grand River. The species has recently spread throughout much of the upper part of the Grand River watershed after a presumed introduction about 10 years ago. The greenside darter was first discovered in the upper East Sydenham River in 1927. Sampling efforts in the 1970s revealed that the species was also present in Bear Creek in the North Sydenham drainage. Sampling conducted in 1997 captured the greenside darter throughout much of the East Sydenham River, as well as at historical sites in Bear Creek. In 2000, the greenside darter was captured in several municipal drains tributary to the Sydenham River.

Percentage of Global Distribution in Canada: Less than 5% of the species' global range occurs in Canada.

Nationally Significant Populations: None has been identified. Significant numbers of this species are found in several watersheds.

Population Sizes and Trends: The greenside darter is globally secure (G5) and appears to be stable throughout much of its range. The species is listed as being of special concern in Mississippi and Kansas. Recent sampling in the Sydenham River has confirmed its continued presence at most historical sites, and substantial numbers were captured at some of the locations (e.g., 46 individuals). The species appears to be stable in the Sydenham drainage.

Biologically Limiting Factors: The greenside darter lays its eggs on filamentous algae attached to rocks in fast-flowing riffle areas. These habitats may be limiting in some systems.

Threats: Dalton (1991) suggested that the specialized feeding and spawning areas (riffle habitats) were at risk from several anthropogenic disturbances, including impoundment, contaminants associated with industry and agriculture, siltation, and low water flows. Although the greenside darter may be limited by turbidity in the Sydenham River, it appears to be maintaining its range and abundance levels throughout much of the system under current conditions. The greenside darter does not appear to be as sensitive to the common threats that are affecting other species in the

system. The greenside darter is one of the few species in the Sydenham River that inhabits streams classed as municipal drains and may therefore be threatened by drain maintenance activities. However, it has persisted in these drains under existing maintenance regimes.

Habitat Requirements:

Recovery Habitat: The greenside darter inhabits rocky riffles of creeks and small to medium-sized rivers and is occasionally found along the shores of large lakes (Page and Burr 1991). Greatest abundance is reached in riffles that are deep and swift with a rubble and boulder substrate (Dalton 1991). Although the greenside darter is most often found in streams of low turbidity, it exists in quite turbid habitats in the Thames and Sydenham rivers. Juveniles and adults may be found in similar habitats. Spawning takes place in the spring once the water temperature is above 11°C and may be protracted over several weeks. Rocks in riffles covered with filamentous algae (usually *Cladophora*) are used as spawning sites (Scott and Crossman 1973). Adhesive eggs are laid on the algae close to the rock and hatch in about three weeks. Recovery habitat could be considered as riffles and runs in the entire East Sydenham River and tributaries (Cold Creek, Brown Creek, Fansher Creek, Haggerty Creek) and Bear Creek.

Survival Habitat: It is difficult to quantify survival habitat for this species, which is widespread in the Sydenham River system.

Habitat Trends: The quantity and quality of greenside darter habitat in the Sydenham River have not been assessed. Given that the range and abundance of the greenside darter appear stable, trends in habitat are probably similar.

Habitat Protection/Ownership: The habitat of the greenside darter receives general protection under the habitat provisions of the federal Fisheries Act. Floodplain regulations enforced by the St. Clair Region Conservation Authority and the Provincial Policy Statement under the provincial Planning Act provide some control over stream-side development. The bed of the Sydenham River is owned by the Crown, but the majority of adjacent lands on the portion of the river inhabited by the greenside darter are privately owned and in agricultural use.

Ecological Role: The greenside darter feeds on small benthic invertebrates that live in riffle areas of streams. Aquatic insect larvae (primarily midges, caddisflies, and blackflies) make up the majority of the diet (Dalton 1991).

Socioeconomic Considerations: The greenside darter is a legal baitfish in Ontario and may be occasionally incidentally harvested for use as bait. The greenside darter is one of Canada's more beautiful freshwater fishes and may have potential as an aquarium fish, but it is currently not part of the trade.

Recovery Potential and Rationale:

Ecological and Technical Feasibility of Species Recovery:
(i) The maintenance of existing range and population abundance is all that is required to "recover" the greenside darter.
(ii) Given the distribution and abundance of the greenside darter in the Sydenham River system, quality habitat appears to be in good supply.
(iii) and (iv) The species has thrived under existing protection measures and land use practices, and additional recovery measures will only enhance habitat and benefit the species.
(v) Captive breeding and repatriation will not be considered for this species.

The level of effort required for recovery of the Sydenham population would be low (habitat protection).

Anticipated Conflicts or Challenges: None.

Knowledge Gaps:

Survey Requirements: The range and abundance of greenside darter should be monitored as part of standard surveys.

Biological/Ecological Research Requirements: None.

Threat Clarification Research Requirements: None.

Bigmouth Buffalo (*Ictiobus cyprinellus*)

Species Information:

Scientific Name: *Ictiobus cyprinellus*

Common Name: Bigmouth buffalo

Current COSEWIC/OMNR Status & Year of Designation: Special Concern (1989); Ontario – Not in Any Risk Category (2000)

Range in Canada (provinces and territories where found): Saskatchewan, Manitoba, and Ontario.

Rationale for Status: This is a rare species in Canada that is subject to exploitation.

Distribution:

Global Range: The bigmouth buffalo ranges widely in the Mississippi River basin, the southern Great Lakes, and the Nelson River basin (Hudson Bay). It is native to 21 states and three provinces and has been introduced to three states.

Canadian Range: In Canada, the bigmouth buffalo has a disjunct distribution in Saskatchewan, Manitoba, and Ontario. In Ontario, the species is known from Lake Erie and Lake St. Clair and their tributaries, as well as from Lake Ontario and Lake of the Woods (evidence suggests Lake of the Woods fish were introduced). Although the species has not been captured from Lake of the Woods since the 1970s, its distribution appears to be expanding in southern Ontario, and it has been discovered in many new drainages in the last 10 years (Welland River, Sydenham River, Grand River, Hamilton Harbour). The bigmouth buffalo was not reported from the Sydenham River at the time its status was assessed by COSEWIC in 1989 (Goodchild 1990). In 1997, a single individual was captured in the lower East Sydenham River, and several fish were captured at two sites in the lower North Sydenham River (E. Holm, Royal Ontario Museum, unpublished data). The bigmouth buffalo can be considered a recent invader of the Sydenham River but could have been misidentified as common carp (*Cyprinus carpio*) or quillback (*Carpiodes cyprinus*) in previous sampling efforts. Fifteen small *Ictiobus* sp. were also collected at a site in the North Sydenham River in 1997. It is possible that these fish represent another species at risk, the black buffalo (*Ictiobus niger*) or hybrids (Holm and Boehm 2001).

Percentage of Global Distribution in Canada: Less than 5% of the species' global range occurs in Canada.

Nationally Significant Populations: None has been identified. The largest populations may be in the Saskatchewan River system, where this species has been commercially fished in the past.

Population Sizes and Trends: The bigmouth buffalo may have only recently colonized the Sydenham River and could represent an expanding population. The size of the population is unknown.

Biologically Limiting Factors: The bigmouth buffalo requires spring flooding for successful spawning and may also be limited by cold winter temperatures.

Threats: The bigmouth buffalo is not as sensitive to human disturbance and in fact may benefit from habitat changes that are detrimental to sensitive species. Efforts to reduce erosion and nutrient loading are unlikely to limit opportunities for the bigmouth buffalo in the Sydenham River.

Habitat Requirements:

Recovery Habitat: Bigmouth buffalo can occupy a variety of habitats — they inhabit the main channels, pools, and backwaters of small to large rivers, as well as lakes and impoundments (Page and Burr 1991). The species has a high tolerance for turbidity and extremely low oxygen levels and exhibits a preference for warm, highly eutrophic waters (Goodchild 1990). Habitat changes resulting from anthropogenic disturbances may enhance habitat for this species. Bigmouth buffalo spawn in spring at water temperatures of 15–18°C. Spawning occurs in shallow bays or small tributary streams, and the fish will invade streams, ditches, and backwaters during spring flooding. Adhesive eggs are scattered over plant debris in shallow water. Recovery habitat could be considered as the lower portions of the North Sydenham and East Sydenham rivers.

Survival Habitat: As per Recovery Habitat.

Habitat Trends: The quantity and quality of bigmouth buffalo habitat in the Sydenham River have not been assessed. As a recent colonizer, it is likely that sediment and nutrient loading (perhaps coupled with increased temperatures) have enhanced habitat for this species in the Sydenham River.

Habitat Protection/Ownership: The habitat of the bigmouth buffalo receives general protection under the habitat provisions of the federal Fisheries Act. Floodplain regulations enforced by the St. Clair Region Conservation Authority and the Provincial Policy Statement under the provincial Planning Act provide some control over stream-side development. The bed of the Sydenham River is owned by the Crown, but the majority of adjacent lands on the portion of the river inhabited by the bigmouth buffalo are privately owned and in agricultural use.

Ecological Role: The bigmouth buffalo has been described as primarily a planktivorous feeder, consuming largely crustacean zooplankton in an indiscriminate fashion. However, benthic insects, molluscs, and crustaceans are also consumed (Goodchild 1990). Differing diets of the same life stages in different water bodies suggest that the bigmouth buffalo is really an opportunistic feeder with the capability of using both pelagic and benthic foraging habits (Goodchild 1990).

Socioeconomic Considerations: In Ontario, the bigmouth buffalo is incidentally harvested as a coarse fish in commercial fisheries and has been targeted in Saskatchewan commercial fisheries.

Recovery Potential and Rationale:

Ecological and Technical Feasibility of Species Recovery:
(i) The bigmouth buffalo is currently expanding its range in Ontario and so has the ability to rebound demographically.
(ii) Much of the lower Sydenham River system provides good habitat for the bigmouth buffalo.
(iii) and (iv) The bigmouth buffalo has prospered in the Sydenham River under existing conditions. Recovery efforts for other species that result in improved water quality will likely benefit the bigmouth buffalo.
(v) Captive breeding and repatriation will not be considered for this species.

Recovery is feasible with minimal effort.

Anticipated Conflicts or Challenges: Recovery efforts for other species that result in improved water quality are unlikely to have a negative impact on bigmouth buffalo.

Knowledge Gaps:

Survey Requirements: The range and abundance of bigmouth buffalo should be monitored as part of standard surveys.

Biological/Ecological Research Requirements: None.

Threat Clarification Research Requirements: None.

Eastern Spiny Softshell (*Apalone spinifera spinifera*)

Species Information:

Scientific Name: *Apalone spinifera spinifera*

Common Name: Eastern spiny softshell

Current COSEWIC/OMNR Status & Year of Designation: Threatened (1991); Ontario – Threatened (1991)

Range in Canada (provinces and territories where found): Southern Quebec and southern Ontario

Rationale for Status: This is a rare species in Canada that has declined due to habitat loss, with remaining populations scattered.

Distribution:

Global Range: The eastern spiny softshell is one of seven subspecies of the spiny softshell turtle that is widespread in the eastern United States (west of the Appalachians). The eastern subspecies occurs in the Mississippi River–Ohio River system and the lower Great Lakes (Obbard 1991).

Canadian Range: In Canada, the eastern spiny softshell is known from the drainages of Lake St. Clair, Lake Erie, and western Lake Ontario in Ontario and from the Ottawa, St. Lawrence, and Richelieu rivers in Quebec. A survey of the Sydenham River by Fletcher and Gillingwater (1994) found 87 eastern spiny softshells in a continuous stretch of the middle portion of the East Sydenham River from Napier downstream to Croton. No softshells were observed in the lower East Sydenham River or in Bear Creek. However, there are documented occurrences of eastern spiny softshells from the lower portion of the North Sydenham River in Sombra Township. It should be noted that the 1994 survey may be biased due to the timing of the inventory. The majority of softshells appear to be most active in spring and early summer. Further research is needed.

Percentage of Global Distribution in Canada: Less than 5% of the species' global range occurs in Canada.

Nationally Significant Populations: None has been identified. The largest populations in Ontario occur in the Thames and Sydenham rivers and at two sites along Lake Erie.

Population Sizes and Trends: The historical status of the eastern spiny softshell in the Sydenham River basin is unknown, so little can be said regarding population trends.

Biologically Limiting Factors: To avoid predation, young softshells utilize shallow water areas and bury into sand or mud substrates. Nest sites occur above the summer water line and consist of vegetation-free sand or gravel areas adjacent to the river. These habitats are limited in the Sydenham River.

Threats: Habitat loss and fragmentation are the major threats to eastern spiny softshells in Ontario (Oldham et al. 1997). Shoreline stabilization and development are the largest contributors to habitat loss. Projects designed to control erosion should consider impacts on eastern spiny softshell habitat. On the Sydenham River, nesting habitats appear to be in limited supply, which may explain the long distances travelled by individual turtles. High rates of nest predation (by raccoons, *Procyon lotor*, striped skunks, *Mephitis mephitis*, red fox, *Vulpes vulpes*, coyote, *Canis latrans*, and fly larvae) are a serious problem for softshells in Ontario (Obbard 1991). Pollutants and contaminants

affecting prey species or the reproductive potential of softshells may be a limiting factor. Other significant threats include flooding during the incubation period, illegal harvest, and vegetative overgrowth of nesting habitat (Oldham et al. 1997).

Habitat Requirements:

Recovery Habitat: Eastern spiny softshells inhabit soft-bottomed water bodies with aquatic vegetation, an abundance of prey sources, and an availability of nesting sites. Resting softshells bury themselves in mud and sand bottoms in shallow water to avoid predation (Obbard 1991; Oldham et al. 1997). These habitats are particularly important for young turtles. The availability of basking areas is also import to softshells. Eastern spiny softshells bask on river banks where vegetation does not block sunlight, as well as on logs, rocks, and some artificial structures. Bank stabilization and shoreline "improvements" such as gabion baskets can restrict access for softshell basking and nesting (Oldham et al. 1997). Deep pools (>1 m) are important for hibernating softshells and also provide cover, food, and thermoregulation opportunities during the summer. On the Sydenham River, radiotelemetry has revealed that individual turtles will move as much as 30 km in a single season between nesting and hibernation sites (Fletcher 1996). Since the key features of habitat are not always in proximity, it is essential that these habitats remain connected (Oldham et al. 1997). In Ontario, eastern spiny softshells lay one clutch of about 20 eggs per year from mid-June to mid-July (Obbard 1991; Oldham et al. 1997). Female softshells prefer to lay eggs in sandy, sunlit areas above the summer high-water level (Oldham et al. 1997). These habitats are normally found on the inside of a river bend downstream of eroding sandy slopes. There appears to be a shortage of these preferred nesting habitats on the Sydenham River, and the majority of nest sites are in hard-packed clay soil that becomes rock-hard by late summer (Fletcher 1996). Several turtles may nest in the same area. Farmland adjacent to the river may remain open to nesting females, but eggs have been found crushed by cattle at some sites. Recovery habitat could be considered as the entire reach of the East Sydenham River between Strathroy and Dawn Mills and the portion of the North Sydenham River in Sombra Township.

Survival Habitat: Survival habitat should be considered as the entire stretch of the East Sydenham River between Napier and Croton.

Habitat Trends: There is no information on trends in the quantity and quality of softshell habitat in the East Sydenham River. Nesting habitat seems to be in limited supply, but may have always been scarce.

Habitat Protection/Ownership: The habitat of the eastern spiny softshell receives indirect general protection under the habitat provisions of the federal Fisheries Act. Floodplain regulations enforced by the St. Clair Region Conservation Authority and the Provincial Policy Statement under the provincial Planning Act provide some control over stream-side development. The bed of the Sydenham River is owned by the Crown, but the majority of adjacent lands on the portion of the river inhabited by the eastern spiny softshell are privately owned and in agricultural use.

Ecological Role: Eastern spiny softshells are benthic feeders and scavengers that are primarily carnivorous (Obbard 1991). Most studies have shown that crayfish are an important food item. Aquatic insects (dragonflies and mayflies), molluscs, earthworms, fish, tadpoles, and frogs are also consumed.

Socioeconomic Considerations: In Ontario, the eastern spiny softshell is not subject to harvest, as it is classified as Specially Protected Wildlife under the Fish and Wildlife Conservation Act. In other parts of the world, various softshell species are raised/harvested for human consumption and the pet trade. The eastern spiny softshell is of little direct economic significance in Canada, but it is important in the provision of viewing opportunities.

Recovery Potential and Rationale:

Ecological and Technical Feasibility of Species Recovery:
(i) Few turtle species have the inherent capacity to rebound demographically, given their long life spans, late maturation, and low recruitment rates.
(ii) The East Sydenham River provides good habitat for this species, although nesting habitat may be in short supply.
(iii) and (iv) In addition to overall watershed approaches to improving habitat, individual nesting site management is required to improve habitat and provide protection from predators.
(v) Artificial incubation of eggs laid in the wild can be used to increase hatching success.

The objectives of the draft recovery plan for the eastern spiny softshell include maintaining current population numbers and preventing loss of habitat for southwestern Ontario populations. This should be feasible with moderate effort on the Sydenham River through stewardship, habitat protection and improvement, awareness, and monitoring activities.

Anticipated Conflicts or Challenges: As per other species.

Knowledge Gaps:

Survey Requirements: Surveys conducted by the Upper Thames River Conservation Authority should be repeated every 5 years. For best results, river surveys should be conducted in May and June; after this time, the thermoregulatory behaviour is much reduced. Surveys for nest sites may also be conducted in June–July and possibly August, using predated eggs as an indicator of turtle presence.

Biological/Ecological Research Requirements: Important basking areas, nesting sites, and overwintering habitats need to be identified.

Threat Clarification Research Requirements: Impacts of succession and predation on nest sites should be investigated.

Appendix 2.
Species at Risk Definitions

This appendix provides the status, G-Rank, and S-Rank definitions as assigned by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), Ontario Ministry of Natural Resources (OMNR), and The Nature Conservancy.

* * * * *

COSEWIC Status
Status assigned to species by COSEWIC

EXT Extinct. A species that no longer exists.

EXP Extirpated. A species no longer existing in the wild in Canada, but occurring elsewhere in the wild.

END Endangered. A species facing imminent extirpation or extinction throughout its range.

THR Threatened. A species likely to become endangered if nothing is done to reverse the factors leading to its extirpation or extinction.

SC Special Concern. A species of special concern because of characteristics that make it particularly sensitive to human activities or natural events, but does not include an extirpated, endangered, or threatened species.

DD Data Deficient. A species for which there is insufficient information to support a status designation.

NAR Not At Risk. A species that has been evaluated and found to be not at risk.

* * * * *

OMNR Status
Status assigned to species by the Ontario Ministry of Natural Resources

EXT Extinct. Any species formerly native to Ontario that no longer exists.

EXP Extirpated. Any native species no longer existing in the wild in Ontario, but existing elsewhere in the wild.

END Endangered. Any native species that, on the basis of the best available scientific evidence, is at risk of extinction or extirpation throughout all or a significant portion of its Ontario range if the limiting factors are not reversed. Endangered species are protected under the province's Endangered Species Act.

THR Threatened. Any native species that, on the basis of the best available scientific evidence, is at risk of becoming endangered throughout all or a significant portion of its Ontario range if the limiting factors are not reversed.

VUL Vulnerable. Any native species that, on the basis of the best available scientific evidence, is a species of special concern in Ontario, but is not a threatened or endangered species.

IND Indeterminate. Any native species for which there is insufficient scientific information on which to base a status recommendation.

NIAC Not In Any COSSARO Category. Any native species evaluated by the Committee on the Status of Species At Risk in Ontario (COSSARO) that does not currently meet criteria for assignment to a provincial risk category.

* * * * *

Global Rank (G-Rank)

Global ranks are assigned by a consensus of the network of natural heritage programs (conservation data centres), scientific experts, and The Nature Conservancy to designate a rarity rank based on the range-wide status of a species, subspecies, or variety. The most important factors considered in assigning global ranks are the total number of known, extant sites worldwide and the degree to which they are potentially or actively threatened with destruction. Other criteria include the number of known populations considered to be securely protected, the size of the various populations, and the ability of the taxon to persist at its known sites. The taxonomic distinctness of each taxon has also been considered. Hybrids, introduced species, and taxonomically dubious species and varieties have not been included.

G1 Extremely rare; usually 5 or fewer occurrences in the overall range or very few remaining individuals; or because of some factor(s) making it especially vulnerable to extinction.

G2 Very rare; usually between 5 and 20 occurrences in the overall range or with many individuals in fewer occurrences; or because of some factor(s) making it vulnerable to extinction.

G3 Rare to uncommon; usually between 20 and 100 occurrences; may have fewer occurrences, but with a large number of individuals in some populations; may be susceptible to large-scale disturbances.

G4 Common; usually more than 100 occurrences; usually not susceptible to immediate threats.

G5 Very common; demonstrably secure under present conditions.

GU Status **uncertain**, often because of low search effort or cryptic nature of the species; more data needed.

G? Unranked, or, if following a ranking, rank tentatively assigned (e.g., G3?).

G A "G" (or "T") followed by a blank space means that the Natural Heritage Information Centre (NHIC) has not yet obtained the Global Rank from The Nature Conservancy.

Q Denotes that the taxonomic status of the species, subspecies, or variety is questionable.

T Denotes that the rank applies to a subspecies or variety.

* * * * *

Provincial Rank (S-Rank)

Provincial (or Subnational) ranks are used by the NHIC to set protection priorities for rare species and natural communities. These ranks are not legal designations. Provincial ranks are assigned in a manner similar to that described for global ranks, but consider only those factors within the political boundaries of Ontario. By comparing

the global and provincial ranks, the status, rarity, and the urgency of conservation needs can be ascertained. The NHIC evaluates provincial ranks on a continual basis and produces updated lists at least annually. The NHIC welcomes information that will assist in assigning accurate provincial ranks.

S1 Extremely rare in Ontario; usually 5 or fewer occurrences in the province or very few remaining individuals; often especially vulnerable to extirpation.

S2 Very rare in Ontario; usually between 5 and 20 occurrences in the province or with many individuals in fewer occurrences; often susceptible to extirpation.

S3 Rare to uncommon in Ontario; usually between 20 and 100 occurrences in the province; may have fewer occurrences, but with a large number of individuals in some populations; may be susceptible to large-scale disturbances. Most species with an S3 rank are assigned to the watch list, unless they have a relatively high global rank.

S4 Common and apparently secure in Ontario; usually with more than 100 occurrences in the province.

S5 Very common and demonstrably secure in Ontario.

SH Historically known from Ontario, but not verified recently (typically not recorded in the province in the last 20 years); however, suitable habitat is thought to still be present in the province, and there is reasonable expectation that the species may be rediscovered.

SX Extirpated – no longer exists in Ontario.

SR Reported for Ontario, but without persuasive documentation that would provide a basis for either accepting or rejecting the report.

SU Uncertain – often because of low search effort or cryptic nature of the species, there is insufficient information available to assign a more accurate rank; more data are needed.

Appendix 3.
COSEWIC Status Reports

National status reports for the 14 nationally listed aquatic species are available from the COSEWIC Secretariat (in some cases, information is available from published reports):

Mussels:

- Northern Riffleshell (Staton *et al.* 2000a)
- Rayed Bean (West *et al.* 2000)
- Wavy-rayed Lampmussel (Metcalfe-Smith *et al.* 2000)
- Mudpuppy Mussel (Watson *et al.* 2000b)
- Snuffbox (Watson *et al.* 2000a)

Fish:

- Eastern Sand Darter (Holm and Mandrak 1994)
- Greenside Darter (Dalton 1991)
- Blackstripe Topminnow (McAllister 1987; Mandrak and Holm 2000)
- Bigmouth Buffalo (Goodchild 1990)
- Spotted Gar (Parker and McKee 1984a; Campbell 1994b)
- Northern Madtom (Holm and Mandrak 1998)
- Pugnose Minnow (Parker et al. 1987; Cudmore and Holm 1999)
- Spotted Sucker (Parker and McKee 1984b; Campbell 1994a)

Turtles:

- Eastern Spiny Softshell (Obbard 1991)

Contact: COSEWIC Secretariat
Canadian Wildlife Service
Environment Canada
4th Floor, Place Vincent Massey
351 St. Joseph Blvd
Gatineau, QC K1A 0H3
Tel.: 819-953-3215 // Fax: 819-994-3684
E-mail: COSEWIC/COSEPAC@ec.gc.ca

Previous National Recovery Plans

1.	Canadian Whooping Crane Recovery Plan	December 1987
2.	*Anatum* Peregrine Falcon Recovery Plan	October 1988
3.	National Recovery Plan for the Baird's Sparrow	April 1993
4.	National Recovery Plan for the Roseate Tern	June 1993
5.	National Recovery Plan for the Greater Prairie-Chicken	October 1993
6.	National Recovery Plan for the Whooping Crane (1994 update)	January 1994
7.	National Recovery Plan for the Loggerhead Shrike	March 1994
8.	National Recovery Plan for the Marbled Murrelet	May 1994
9.	National Recovery Plan for the Gaspésie Caribou	November 1994
10.	National Recovery Plan for the Vancouver Island Marmot	December 1994
11.	National Recovery Plan for the Ferruginous Hawk	December 1994
12.	National Recovery Plan for the Harlequin Duck in Eastern North America	March 1995
13.	National Recovery Plan for the Burrowing Owl	April 1995
14.	National Recovery Plan for the Newfoundland Marten	August 1995
15.	National Recovery Plan for the Swift Fox	April 1996
16.	National Recovery Plan for the Blanchard's Cricket Frog	March 1997
17.	National Recovery Plan for the Henslow's Sparrow	August 1997
18.	National Recovery Plan for Blandings Turtle (*Emydoidea blandingii*) Nova Scotia population	January 1999
19.	National Recovery Plan for the Vancouver Island Marmot (*Marmota vancouverensis*) 2000 Update	May 2000
20.	National Recovery Plan for Acadian Flycatcher (*Empidonax virescens*) and Hooded Warbler (*Wilsonia citrina*)	November 2000
21.	National Recovery Plan for the Wood Bison (*Bison bison athabascae*)	October 2001
22.	National Recovery Plan for the Piping Plover (*Charadrius melodus*)	March 2002
23.	National Recovery Plan for Long's Braya (*Braya longii Fernald*) and Fernald's Braya *(Braya fernaldii Abbe*)	September 2002
24.	Conservation Strategy for Bowhead Whales (*Balaena mysticetus*) in the Eastern Canadian Arctic	September 2003

Recovery of Nationally Endangered Wildlife

In 1988, the Wildlife Ministers' Council of Canada endorsed a new strategy to rescue wildlife species at risk of extinction and to prevent other species from becoming at risk. Called RENEW (the acronym for Recovery of Nationally Endangered Wildlife), the strategy brings together all responsible agencies and interested organizations and individuals to work as a team for the recovery of wildlife at risk. RENEW focuses on those species or populations that have been designated as extirpated, endangered, or threatened by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). The responsible jurisdictions establish a National Recovery Team of experts for each species to produce a recovery plan, which becomes the basis for a recovery program carried out by the responsible governments in cooperation with aboriginal groups, universities, nongovernment organizations, businesses, and private citizens.

RENEW gratefully acknowledges the assistance of the Canadian Wildlife Service of Environment Canada in producing this report.

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Canadian Wildlife Service | Service canadien de la faune